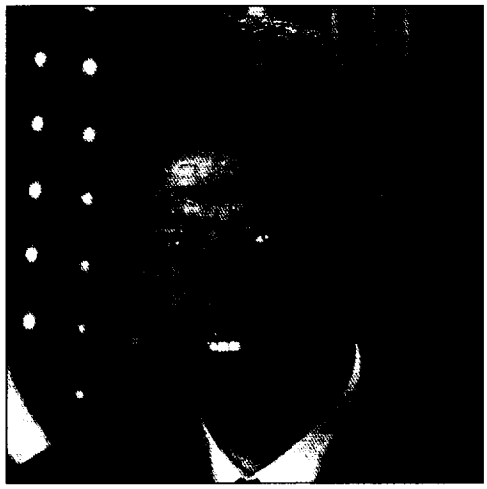
SPACE

PROCEEDINGS REPORT

SPACE NEWS
Official Sponsoring Publication

THE WHITE HOUSE

WASHINGTON



March 15, 1995

Greetings to everyone gathered in Colorado Springs for the eleventh National Space Symposium, sponsored by the United States Space Foundation.

Space presents humanity with some of its greatest challenges and most promising opportunities. The civil, commercial, and defense air and space industries must work together with government to meet our national security interests, and push forward the frontiers of human discovery.

Today, bolstered by our successes throughout the past three decades,We are forming new partnerships between the public and private sectors and among nations everywhere on earth in our mission to chart the heavens. The resulting progress promises to bolster our economy, advance our understanding of medical science, and teach us more about our own place in the universe.

I salute each of you for your commitment to helping humanity realize the limitless potential of space. Your active leadership can inspire a new generation of young people to pursue studies in science and mathematics and to reach for the stars. Your work will change the world of tomorrow in ways that we can only begin to imagine.

Best wishes for a most productive symposium.

Bill Clinton

HONORARY PROCLAMATION

UNITED STATES SPACE FOUNDATION WEEK
APRIL 2-8, 1995

WHEREAS,
the United States Space Foundation will be hosting the 11th National Space Symposium on April 4-7, 1995, in Colorado Springs, Colorado, to discuss space issues and the theme for this event is appropriately entitled, "Vision and Reality, Face to Face;" and

WHEREAS,
this foundation was founded in March 1993 to stimulate dialogue through the interaction among space professionals civil, military and commercial to explore alternatives and focus national space policy; and

WHEREAS,
two technologies, Anti-Corrosion Paint and Parawings and Hang Gliders, developed for America's space program and now widely used in industry and recreation will be inducted into the Space Technology Hall of Fame on April 6, 1995;

NOW, THEREFORE,
I, Roy Romer, Governor of Colorado, proclaim April 2-8, 1995, as

UNITED STATES SPACE FOUNDATION WEEK
in the State of Colorado.

GIVEN
under my hand and the Executive Seal of the State of Colorado, this first day of March, 1995

Roy Romer
Governor

WELCOME

Welcome to the 11th National Space Symposium and to the beautiful Pikes Peak Region.

We gather together to explore America's future in space. Even in the most primitive of civilizations, space has been viewed through the eyes of promise, hope, and vision.

Today, the promises and visions of space are rapidly becoming realities as we find more and more practical applications for space. Applications in Earth observation, GPS, remote sensing, telecommunications, satellites, launch vehicles, security, space stations and more. These applications fuel our desire to further explore the possibilities of space, and further expand our understanding. So, where do we go from here?

Vision and Reality: Face to Face is the theme for this 11th National Space Symposium. During the next few days, some of the world's foremost space authorities and decision makers will join in the dialogue and discussion on issues of visions of our future in space, positioning for the future, remote sensing: an emerging era, opportunities in space, achieving a competitive vision with acquisition reality, national security requirements, and international space opportunities.

And as we explore the future, we must take stock of how to capture the American public's imagination, excitement and involvement in our space endeavors.

I encourage you to take full advantage of this 11th National Space Symposium, from the superb program and speakers to the stimulating exhibits, to the excellent networking opportunities. Be sure to visit the top aerospace and technology industry exhibits in Colorado Hall and see the latest innovations.

Have a great time exploring the visions and realities of our future in space.

Sincerely,

James E. Hill, General, USAF (Ret.)
Chairman of the Board
United States Space Foundation

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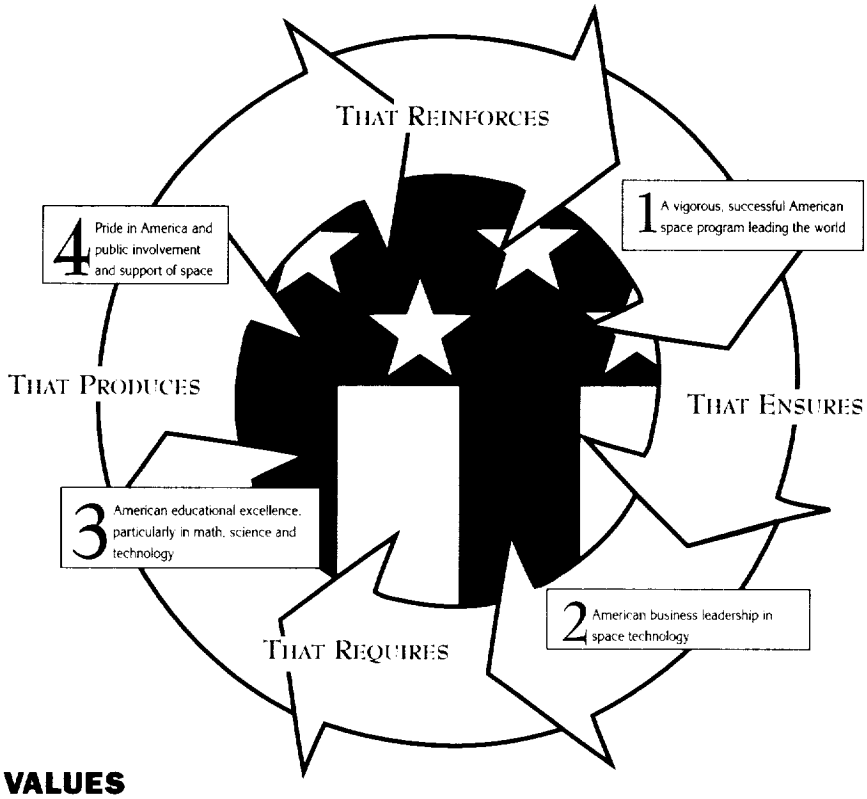
THE UNITED STATES SPACE FOUNDATION

OUR MISSION

To promote national awareness and support for America's space endeavors



VALUES

Integrity and Fairness

Non-Partisan

Quality

Innovation and Creativity

Fiscal Responsibility

Recognition of Staff

Accountability

BOARD OF DIRECTORS

EXECUTIVE COMMITTEE

GENERAL JAMES E. HILL, USAF (Ret.), Chairman

Gen. James Hill served as president of the Colorado Springs-based Olive Company from 1986 to 1993, and president of the Colorado Springs Chamber of Commerce for several years after his retirement from the Air Force. He is a graduate of the University of Maryland and the Royal Air Force Flying School in England. Former commander-in-chief of the North American Air Defense Command, General Hill was an Air Force combat fighter ace in WW II and the Korean Conflict.

WILLIAM B. TUTT, Vice Chairman

Mr. William Tutt is principal of Tutco and chairman emeritus of the Colorado Springs Sports Corporation. He served as vice president of the U.S. Olympic Committee and president of the Broadmoor Management Co. Mr. Tutt is now the chairman of the U.S. Olympic Festival Committee and the co-chairman of the Colorado Thirty Group. Mr. Tutt serves on the board of directors for U.S. West Communications Colorado, the Air Force Academy Foundation (vice president), Norwest Banks of Colorado, and Colorado Interstate Gas Company.

W. BRUCE KOPPER, ESQUIRE, Secretary-Treasurer

Bruce Kopper is president of the investment counseling firm Kopper Investment Management, Inc., in Colorado Springs. Mr. Kopper is a graduate of Washington University in St. Louis, MO, with degrees in economics and law, and is licensed to practice law in Missouri and Colorado. He practiced law for 28 years before entering the investment management business in 1987. He is a member of the Denver Society of Security Analysts and the Association for Investment Management & Research.

WILLIAM H. HUDSON, Director

William Hudson's entire 31-year career was with Corning Glass Works, now Corning Incorporated. When he retired in 1985, he was president of the Glass and Ceramics Group and a member of the Board of Directors, the Executive Committee and the Management Committee. Prior to the Group presidency he was senior vice-president and general manager of the Technical Products Division. Mr. Hudson lived in Paris, France, for more than six years where he was chairman and CEO of Corning's largest overseas subsidiary. He is now a director of Analytical Surveys Inc., Colorado Springs, CO, and investor/adviser in several start-up companies. Mr. Hudson has a degree in physics from Carnegie Institute of Technology and attended the Harvard Business School Advanced Management Program.

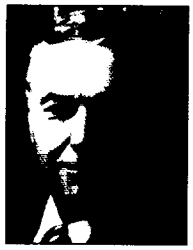
DIRECTORS

EDWARD C. "PETE" ALDRIDGE, JR., Director

Edward C. Aldridge, Jr. is president and CEO of The Aerospace Corporation, a non-profit organization dedicated to the objective application of science and technology toward the solution of critical national problems. Previously, Aldridge served as president of McDonnell Douglas Electronic Systems Company. He also served in many government positions, including Secretary of the Air Force. Aldridge received his undergraduate degree from Texas A&M University and earned his graduate degree from the Georgia Institute of Technology.

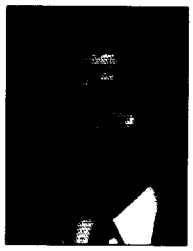
ROBERT ANDERSON, Director

Mr. Robert Anderson is chairman emeritus of Rockwell International Corporation and the immediate past CEO. He earned a bachelor's degree in mechanical engineering from Colorado State University, a master's degree in automotive engineering from the Chrysler Institute of Engineering and spent 22 years with the Chrysler Corporation, rising to vice president of Corporate Automotive Manufacturing. Under his direction, Rockwell shared the 1982 Collier Trophy for the company's work on the Space Shuttle Orbiter, awarded by the National Aeronautic Association for "the greatest achievement in aeronautics of astronautics in America with respect to improving the performance, efficiency or safety of air or space vehicles." He has served as chairman of the Business Higher Education Forum and the board of Aerospace Industries Association.



JAMES M. BEGGS, Director

Mr. James Beggs is the former chairman of the board, SPACEHAB, Inc., and is a principal in Beggs International. As administrator for NASA (1981-1985) he was responsible for initiating and obtaining President Reagan's support for the Space Station program. He was Administrator during 22 successful shuttle flights and was responsible as the President's representative for obtaining cooperation in the Space Station Program of the European Space Agency, Japan and Canada. Mr. Beggs graduated from the U.S. Naval Academy and Harvard Graduate School of Business. He holds six honorary degrees and was awarded the Robert H. Goddard Trophy by the National Space Club in 1988.



COLONEL FRANK BORMAN, USAF (Ret.), Director

Col. Frank Borman, USAF (Ret.) is the chairman, CEO and president of Patlex Corporation. He was the commander of the 1968 Apollo 8 Mission and led the first team of American astronauts to circle the moon. After his retirement from the Air Force, he joined Eastern Airlines and became chairman of the board before he retired from Eastern. He is currently a member of the boards of directors of The Home Depot, AutoFinance Group, Thermo Instrument Systems, and American Superconductor. He earned a B.S. from the U. S. Military Academy, West Point and a M.S. in aeronautical engineering from the California Institute of Technology. He has received the Congressional Space Medal of Honor and the National Geographic Society's Hubbard Medal. He was inducted into the International Aerospace Hall of Fame in 1990 and the U.S. Astronaut Hall of Fame in 1993.

CAPTAIN EUGENE A. CERNAN, USN (Ret.), Director

Captain Eugene A. Cernan is chairman of the Board and president of The Cernan Corporation and The Cernan Group, Inc. He also serves as Chairman of Johnson Engineering Corporation. Captain Cernan was an executive consultant for Aerospace and Government for Digital Equipment Corporation from 1986-1992. From 1976 to 1981, he was international executive vice president for Coral Petroleum, Inc. Prior to 1976, he was a naval aviator and NASA astronaut. He flew three separate space missions, Gemini IX, Apollo X, and holds the distinction of being the last man to leave his footprints on the surface of the moon as commander of Apollo XVII. Captain Cernan received a bachelor of science in electrical engineering from Purdue University and a master of science in aeronautical engineering from the U.S. Naval Post Graduate School, honorary doctorates of engineering from Purdue, Drexel and Gonzaga Universities and an honorary doctorate from Western State College of Law.

THE HONORABLE E. J. "JAKE" GARN, Director

E. J. "Jake" Garn was named vice chairman of Huntsman Chemical Corporation in Salt Lake City, Utah, in 1993 after he retired from the U.S. Senate where he served three terms. During his 18 years in the Senate he served as chairman of the Senate Committee on Banking, Housing and Urban Affairs, VA, HUD, and the Independent Agencies Subcommittee. He received a B.S. in Banking and Finance from University of Utah. He served in the U.S. Navy as a pilot and is a retired a Brigadier General in the Utah Air National Guard with more than 10,000 hours of flight experience. He was invited by NASA to fly as a payload specialist on the space shuttle Discovery, flight 51-D, in 1984. During his 109 orbits of the earth he conducted various medical tests. In 1992 he was honored with the Wright Brothers Memorial Trophy. He serves on several boards including, Dean Witter Funds of New York City, The Aerospace Corporation, and the Salt Lake City Airport Authority.

SAM F. IACOBELLIS, Director

Sam F. Iacobellis is former deputy chairman for major programs and executive vice president, and chief operating officer of Rockwell International. He worked with key customers and Rockwell businesses on large government programs including the Space Station, Space Shuttle, B-1B, National Aero-Space Plane, Ground Based Interceptor, Brilliant Eyes and Joint Primary Aircraft Training Systems programs. He joined Rockwell's predecessor company, North American Aviation, in 1952 as an aircraft design engineer. He also has served Rockwell as president of aerospace operations. He received a bachelor of science degree in mechanical engineering at California State University at Fresno, and a master of science degree in engineering at University of California at Los Angeles. He is a fellow of the International Academy of Astronautics and a fellow of the American Institute of Aeronautics and Astronautics.

DR. JOHN L. McLUCAS, Director

Dr. John McLucas is an Aerospace Consultant, Chairman of the Board of External Tanks Corp., and on the Board of Directors of Orbital Sciences Corp. Dr. McLucas was Secretary of the Air Force from 1973 to 1975. He has served as Chairman of the International Space University, as NATO's Assistant Secretary for Science, president and CEO of MITRE Corporation, Under Secretary of the Air Force, FAA Administrator, executive vice president of COMSAT, president of COMSAT World Systems Division and president of COMSAT General. A space authority, Dr. McLucas is the former U.S. Chairman of the International Space Year Association and chairman of NASA's Advisory Board. He is the author of the book **Space Commerce**, published in April, 1991, by Harvard University Press. He earned his bachelor's degree from Davidson College, his master's degree from Tulane University and his Ph.D. from Penn State University, all in physics.

THE HONORABLE BILL NELSON, Director

Bill Nelson was recently elected Treasurer and Insurance Commissioner of the State of Florida. He has been a practicing attorney since 1970, graduating from the University of Virginia Law School, J.D. in 1968 and until his election was an attorney with Maguire, Voorhis & Wells, P.A. in Melbourne, Florida. He served in the U.S. Army as a Captain from 1968-1970. Nelson trained and flew with the crew of STS-61C, Columbia, the 24th flight of the Space Shuttle in 1986. Among his publications is his book, *MISSION: An American Congressman's Voyage to Space.* Nelson served with the U.S. House of Representatives from 1979 to 1991, representing the 11th Congressional District in Florida and the Florida House of Representatives from 1972 to 1978.

RICHARD D. O'CONNOR, Director

Richard D. O'Connor is chairman and chief executive officer of Lintas:Campbell-Ewald Company and a board member of Lintas Worldwide, an international advertising agency. Mr. O'Connor joined Campbell-Ewald in 1956 as a trainee on the Chevrolet account and held various positions with the company. Mr. O'Connor is chairman of the American Advertising Federation, and is a member of the Menninger Foundation Board of Trustees. He is a graduate of the University of Michigan.

GENERAL JOHN L. "PETE" PIOTROWSKI, USAF (Ret.), Director

General Pete Piotrowski retired from the Air Force as commander-in-chief of the North American Aerospace Defense Command and the United States Space Command. The general has logged more than 5,000 flying hours, including 100 combat missions and 210 combat flying hours. He has received numerous awards, including the Defense Distinguished Service Medal, Distinguished Service Medal, Legion of Merit and the Eugene M. Zuckert Management Award for 1979. He graduated with a B.S. from the University of Nebraska at Omaha in 1965. He completed postgraduate work at the University of California and Auburn University and attended the program for management development at Harvard University.

DR. WESLEY W. POSVAR, Director

Dr. Wesley W. Posvar is professor of International Politics and president emeritus of the University of Pittsburgh. He is a founding member and former chairman of the Business-Higher Education Forum, an organization composed of the chief executives of about 30 of the nation's most powerful corporations and a like group of presidents of leading universities. In this capacity he leads efforts to improve national awareness and action in such areas as capital formation, international competitiveness, science and technology, research and regulatory reform. He was founding chairman of the Federal Emergency Management Advisory Board and of the National Advisory Council on Environmental Policy and Technology. He is presently Trustee Chairman of the Czech Management Center in Prague. He is a graduate of the U.S. Military Academy where he graduated first in his class. He was a professor at West Point and the founding chairman of the Political Science Department of the Air Force Academy. General Posvar was a Rhodes Scholar at Oxford, a Littauer Fellow at Harvard and Research Fellow at the MIT Center for International Studies.

HON. KENNETH B. KRAMER, Director Emeritus

A former four-term United States Representative, Ken Kramer is an Associate Judge for the U.S. Court of Veterans Appeals. He is a graduate of the University of Illinois and the Harvard School of Law. Judge Kramer was a founding member of the United States Space Foundation. He served as a Colorado State Representative from 1973 to 1978. Mr. Kramer is a former Assistant Secretary of the Army for Financial Management. He also served on the USAF Academy Board of Visitors.

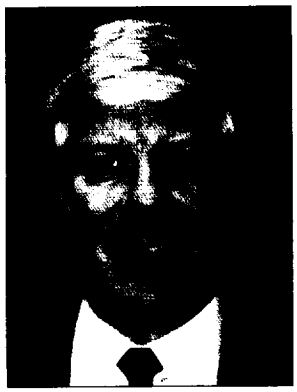
DR. SIMON RAMO, Director Emeritus

Dr. Simon Ramo, recipient of the Presidential Medal of Freedom and the National Medal of Science, is co-founder of TRW Inc. He has been chairman of the President's Committee on Science and Technology and chief scientist in the development of the U.S. Intercontinental Ballistic Missile. He has been a member of the Advisory Council to the Secretary of State on Science and Foreign Affairs, the White House Council on Energy Research and Development, the Advisory Council to the Secretary of Commerce and the National Science Board. A visiting professor at Caltech, he has been a Fellow of the Faculty of the Kennedy School of Government at Harvard University and chairman of UCLA School of Medicine Planning Committee.

FOUNDATION EXECUTIVES

RICHARD P. MacLEOD, President

Dick MacLeod was named president of the United States Space Foundation in 1988 after serving as Executive Director since 1985. Under his leadership the National Space Symposium has become a premier event that provides broad pro and con space policy dialogue; the Foundation established, with NASA, the Space Technology Hall of Fame; and launched Getting Comfortable Teaching with Space, the cornerstone of the Foundation's educational programs. MacLeod is well known to many space organizations as a cooperative innovator and has served on the Space Policy Advisory Board for the Vice President. While a senior research fellow at the National Defense University, he co-authored *Space A National Security Dilemma.* He concluded his 24-year Air Force career as chief of staff, NORAD and the first chief of staff, Air Force Space Command. He received a bachelor of arts in government from the University of Massachusetts and a master of arts in international relations from the University of Southern California. He is also a graduate of the Armed Forces Staff College, the National War College, the State Department Interdepartmental Seminar on Foreign Policy and is a distinguished graduate of the Industrial College of the Armed Forces.



JACK FLANNERY, Executive Director

Jack Flannery joined the U.S. Space Foundation as executive director in January 1991. Responsible for the day-to-day operations of the Foundation he has brought new focus and efficiency to the organization through strategic and operational planning. The Foundation's education programs have also expanded dramatically and new, innovative public outreach and education programs have been developed. Formerly vice president of Flight Safety Services Corporation, he was responsible for the company's Space Training Systems and Instructional Systems Divisions providing state-of-the-art training solutions for government and industry clients. Mr. Flannery completed a 27-year career as Air Force Space Command's Director of Training, Standardization and Evaluation where he introduced a completely redesigned architecture for space operations missions training systems. He holds an M.B.A. from Auburn University and a B.S. in electrical engineering from the Air Force Institute of Technology.

1995 United States Space Foundation Awards

DOUGLAS S. MORROW PUBLIC OUTREACH AWARD

President Ronald Reagan congratulating Doug Morrow on his successful efforts to promote America's space programs.

Douglas S. Morrow, born in 1913, is best known for his work in the entertainment industry. Among the numerous awards bestowed upon him, Morrow received the Academy Award for Best Screen Play in 1949 for writing "The Stratton Story," staring Jimmy Stewart and June Allison. Morrow also received the Golden Dove Award and NAACP Image Award as producer of the year and motion picture of the year for "Maurie" in 1973. Additionally, Morrow produced over 200 television programs.

In 1984, at age 71, Morrow climbed Mount Everest to an altitude of 21,000 feet. Interested in Morrow's physical abilities for a man his age, NASA approached Doug to study the physiological factors involved in such a feat. Morrow entered Astronaut training and a year later was NASA certified for space flight. Morrow went on to serve on NASA's Advisory Council and as Co-Chairman of its Subcommittee on Communications. For this work, Morrow was honored by both NASA and the United States Congress.

In 1991, the American Institute of Aeronautics and Astronautics awarded Morrow its Public Service Award for his outstanding efforts in supporting the national space program.

Doug Morrow created and produced the United States Space Foundation public service television and radio campaign, *Space Technology—This is What's In It For You.* This series of public service announcements promoted the Earthly benefits of the American space program.

The Douglas S. Morrow Public Outreach Award is presented in memory of the late Douglas S. Morrow; renown writer, film producer, space advocate and former U.S.Space Foundation Director; to an individual or organization for outstanding achievement in the promotion of America's space endeavors.

1995 DOUGLAS S. MORROW PUBLIC OUTREACH WINNER
DISCOVERY COMMUNICATION, INC.

The 1995 Douglas S. Morrow Public Outreach Award is presented to Discovery Communications, Inc. for extraordinary efforts in promoting America's space endeavors before the public. Through its Discovery Channel, DCI produced and televised the documentary "Space Shuttle" giving the American public a window into the heart and soul of those individuals who devote their professional lives to sending the space shuttle into space and returning it to earth safely.

In addition to the Discovery Channel, DCI also owns and operates The Learning Channel and numerous other electronic media outlets. The Discovery Channel has become one of the fastest growing cable television networks ranking fourth in size, with 62 million subscriber households in the U.S. alone.

1995 EDUCATION PARTNERSHIP AWARD

The United States Space Foundation Education Partnership Award was established to recognize exceptional achievement in promoting excellence in education. If America is to remain competitive in the global marketplace by retaining a position of leadership in science and technology, our educational systems must become more effective.

Our young people must be motivated to achieve in education to prepare themselves to live and prosper in the high-tech society of the information age.

Meeting this challenge requires significant direct involvement of others with educational institutions. The Education Partnership Award is presented to those who have demonstrated this involvement working with the United States Space Foundation and who have achieved extraordinary results.

THE 1995 EDUCATION PARTNERSHIP AWARD WINNER
TEAM VANDENBERG

The 1995 Education Partnership Award is presented to Team Vandenberg for its strong support of K-12 education programs in California's Central Coast region. Team Vandenberg is a collective reference to a number of organizations at Vandenberg Air Force Base, Calif. working in partnership with NASA, Allan Hancock College, Santa Maria, California, California Polytechnic State University and the United States Space Foundation.

Vandenberg is the nation's third largest U.S.Air Force Base, serves as headquarters for 14th Air Force, and home of the 30th Space Wing whose responsibility is to safely launch U.S.polar-orbiting satellites and test firing intercontinental ballistic missiles.

SPACE ACHIEVEMENT AWARD

The United States Space Foundation Space Achievement Award is established to recognize outstanding achievement in space policy, space professionalism and/or space-related business.

The future of space exploration and exploitation will require the best ideas in technology, industry and policy. As humankind leaves earth to inhabit space and other worlds, the lessons of history, science and the principles of law and government must go with them.

The Space Achievement Award is presented to those who have demonstrated their dedication to the evolution of America's space endeavors.

1995 SPACE ACHIEVEMENT AWARD WINNER
AIR UNIVERSITY

The 1995 Space Achievement Award is presented to Air University for its strong commitment to research of American space policy as it will evolve in the future by producing its comprehensive report Spacecast 2020.

Air University provides several forums for predominately U.S.Air Force officers of all ranks to pursue their continued education in the principles of leadership, tactics, resource management and teamwork. Located at Maxwell Air Force Base, Alabama, Air University has prepared the top leaders in the military today to employ the principles of aerospace in the best interests of the United States.

CORPORATE MEMBERS

The United States Space Foundation is proud to have the strong support of corporations and individuals who share the vision of an aggressive, successful American space program leading the world. They believe this vision is an essential component in ensuring American business leadership in space and technology critical to keeping our nation successful in an ever more competitive global economy.

CORPORATE MEMBERS

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Donald E. Smith

To learn how to participate as a corporation or individual contributor, please contact the United States Space Foundation. We will work together to achieve mutual goals.

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Moods in Blue

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HUGHES ELECTRONICS

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Rockwell

RECEPTIONS & LUNCHEONS

Tuesday Opening Reception

UNITED TECHNOLOGIES Space Propulsion Operations

UNITED TECHNOLOGIES CHEMICAL SYSTEMS

Wednesday Reception

Westinghouse

LOCKHEED MARTIN

Thursday Symposium Luncheon

EOSAT

SPECTRUM ASTRO

Media Luncheon

ANALYTICAL GRAPHICS

Space Technology Hall of Fame Reception

ITT AEROSPACE/COMMUNICATIONS DIVISION

COFFEE BREAKS

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SPACE NEWS

UNITED STATES SPACE FOUNDATION

VOLUNTEERS & STAFF

Volunteers are key to the success of many of the United States Space Foundation's endeavors. Hundreds of volunteers work with the Foundation throughout the year. Nearly 200 volunteers are assisting in the 11th National Space Symposium. We salute them and thank them!

VOLUNTEER COMMITTEE CHAIRMEN

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Rick Hargrave	*Media*
Leslie Hayden	*Transportation Co-Chair*
Jerry Lemberger	*Security*
Sheila Lemberger	*Transportation Co-Chair*
Steve Lootens	*Student Tours*
Frank Ocasio	*Transportation*
Christopher Regan	*Speaker Response Team*
Jim Rix	*Information Booth*
Pat St. John	*Space Support Forum*
Bret Stoneking	*Security Co-Chair*
Frank Wisneski	*Exhibit Support*

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Opening Ceremony
A Tribute to Apollo 13

Opening Remarks: **Dr. Buzz Aldrin**
Lunar Module Pilot, Apollo 11

Honoree: **Capt. James A. Lovell, USN (Ret.)**
Commander, Apollo 13

Featured Speaker: **Dr. France Córdova**
Chief Scientist, NASA

DR. BUZZ ALDRIN: It is my great pleasure to be here to pay tribute to the fine Apollo 13 team—several of whom have just arrived through the generosity of Rockwell, the marvel of modern space transportation and, of course, the theatrical prowess of the U.S. Space Foundation.

It is appropriate that Rockwell play a key role in this tribute, because it had such a fundamental role in the Apollo program 25 years ago. Now, as our HYSTAR delivery system departs, I am truly honored to introduce to you some of the key participants of that dramatic Apollo 13 mission that caused America to hold its collective breath until the astronauts were safely back on Earth.

First, and I say first because they did come before the astronauts, and none of us could have performed our missions without the incredibly talented mission control teams: Glynn Lunny, flight director of the Black Team, who worked closely with the other flight directors; Gene Kranz; Gerry Griffen; and Milt Windler, who led everyone in mission control in coming up with the solutions to every challenge that mission offered.

Next, representing Astronaut and Colorado Congressman Jack Swigert, who unfortunately died of cancer in 1983, is his sister Virginia Swigert. Finally, the commander of the Apollo 13 mission, a good friend and one of my personal heroes, Captain Jim Lovell, United States Navy (Retired). He joined NASA in 1962 and flew a total of four missions before his retirement in 1973. The crew of Apollo 8—America's first mission to the moon—was named "Time's Men of the Year."

Captain Lovell holds a bachelor of science from the U.S. Naval Academy and eight honorary doctorates from such schools as Blackburn University, Rockhurst College and Milwaukee School of Engineering. His honors include the Presidential Medal for Freedom; the NASA Distinguished Service Medal, twice; and two Navy Distinguished Flying Crosses. Ladies and gentlemen, astronaut and true American hero, Jim Lovell.

CAPT. JIM LOVELL: Thank you, Buzz, and I appreciate your introduction of some of the great team members that made the return of Apollo 13 possible. My hat is off to you too, for over the years you have continued to promote our space activities. You and your teammates occupy a great place in history, and what a boost that Apollo 11, our first moon landing, gave to America in so many ways.

I wish that my crewmate, Fred Haise, could join me tonight. But Fred is still actively involved in the aerospace business and had a previous commitment.

Today gave me a chance to renew acquaintances with a few members of the Apollo 13 team, and I am, naturally, very proud of all the men and women who worked on that flight and were responsible for our safe return. And we are all proud of the thousands of talented and dedicated people who continue to push the boundaries of space today.

On behalf of all those involved in America's space programs, I would like to thank the United States Space Foundation for the important work it does in promoting national awareness and support for America's space endeavors. It is indeed an honor to be a part of this event tonight.

Mercury, Gemini, and Apollo missions were not just about beating the Soviets to the moon. They also were about challenging this nation to do the hard things that would make it great and keep it great.

It is particularly significant and appropriate that the United States Space Foundation host this tribute because when it was founded in 1983, it was dedicated to the memory of my crewmate, Colorado Congressman and astronaut Jack Swigert.

It was Jack who first suggested we put down on paper the perilous saga of the 13th flight. Shortly after the mission, he visited with the author Ernest Gann, an aviation adventure writer. Gann suggested an outline on structuring the story. Jack faithfully made copies and sent them to Fred and myself. But the best intentions are often forgotten as we drifted into different careers. It wasn't until I retired the second time that I remembered the promise to write the story. Jack was the motivator when I started to do research for the book and look back on the heady days of America's early space program.

I think it is important to remember what was driving us so hard.

Mercury, Gemini, and Apollo missions were not just about beating the Soviets to the moon. They also were about challenging this nation to do the hard things that would make it great and keep it great. The challenge by President Kennedy marshaled the best any country in the world had to offer in those days—government, industry, and academia—and inspired magnificent achievements in science, technology, health, and education. That challenge also created a unity and national pride that had never been achieved in peacetime before or, regrettably, since.

The Apollo 13 mission that riveted the world's attention for several days was not just about a handful of people trying to save three astronauts. It was about something much larger than that. It was about American resolve and resourcefulness in the face of competing beliefs. It was about the value this nation places on human life and its commitment to promises. It was about trust. It was about courage—yes, to some degree, at the personal level. But more importantly the courage of our national leaders, first to make such an outlandishly visionary commitment to go to the moon, but then to stick to it through some perilous trials. That decision to send Apollo 8 to the moon was a bold move.

If the day ever comes that the United States of America is intimidated by failure and quits because it was too risky—or too hard or too expensive—that day will mark the final decline of the greatest nation in modern history. The leaders who make that decision will forever carry the burden of failed trust and broken promises. They also will carry the burden of forsaking the heritage of this great nation's pioneers of every era.

Recall that the '60s were not tranquil times. We had a very unpopular war in progress sapping enormous national resources. We had civil rights and social upheaval. We had major nuclear threats with "mutual assured destruction" breathing down our backs everyday. There was unrest in the universities. And the hippie generation was lobbying hard to undermine the values that our nation was founded upon.

Yet we prevailed. We succeeded in the greatest achievements humans have ever known. Not all missions went as planned. One ended before it started with the death of three of our close friends on the launch pad. Ours ended successfully back on Earth but—much to my personal disappointment—not on the moon.

But we didn't quit. And thankfully we didn't quit after the Challenger disaster either. And let's hope we won't quit in the face of the next serious setback, because the human quest for knowledge will continue. The only question is whether America will continue to be a leader of that quest. Exploration, pushing the boundaries of the unknown, will always be a hazardous proposition. And people will die pushing those boundaries.

Let me leave you with this thought. If the day ever comes that the United States of America is intimidated by failure and quits because it was too risky—or too hard or too expensive—that day will mark the final decline of the greatest nation in modern history. The leaders who make that decision will forever carry the burden of failed trust and broken promises. They also will carry the burden of forsaking the heritage of this great nation's pioneers of every era. Thank you.

Featured Speaker

DR. FRANCE CÓRDOVA
NASA Chief Scientist

We are seeing a lot of profound changes going on at NASA these days. The one that I want to talk about this evening is how NASA is setting its course for the future. With all the reinventing, downsizing, and streamlining, where is it that we are going? Do we have a compelling vision for our next era in space?

In the past, the approach to the future was driven by competition with the Soviet Union. NASA's feats were ones of technical daring-do, designed to show superior competence in engineering. All this changed with the end of the Cold War. Today we are in the process of formulating a vision for the future that is driven by the search for answers to fundamental questions about planet Earth, its neighborhood—the solar systems, and the universe. . . and by fundamental questions about ourselves, the origin of life, and the possibility of finding other planets that are alive. We still need to demonstrate excellence in engineering, but we need to do this to accomplish our scientific goals, not just to demonstrate technical superiority. We realize that we can do much more in partnership: at home, by uniting federal government with industry and academia, and abroad, by forming international alliances. Instead of talking about competing with Russia, we are looking for more ways to collaborate with her and with many other countries.

How are we building a road map for the future? One of our ways is quite extraordinary, and it is this way that I want to share with you. NASA headquarters sits adjacent to a huge highway in southwest Washington, D.C. It's a block-long, unmemorable building containing only offices, almost all of the modular and gray. It's not a work of art. The only

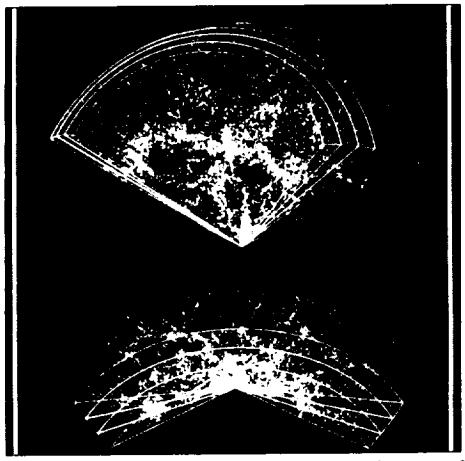


Figure OC-1: The non-uniform distribution of galaxies (from Drs. Geller and Huchra).

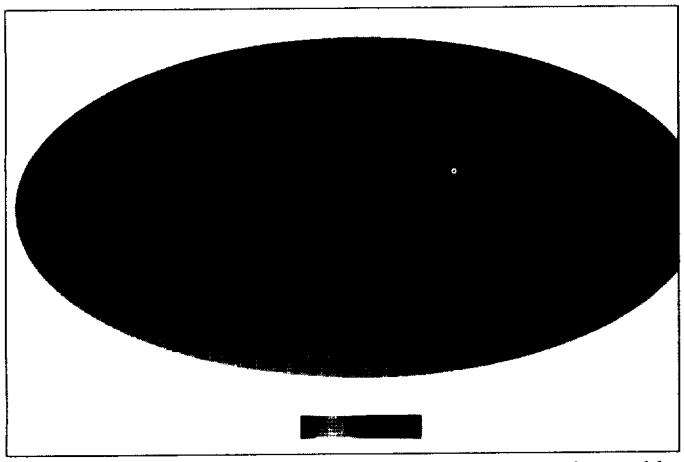


Figure OC-2: Smooth 3 degrees Kelvin background as observed by NASA's Cosmic Background Explorer Satellite, or COBE.

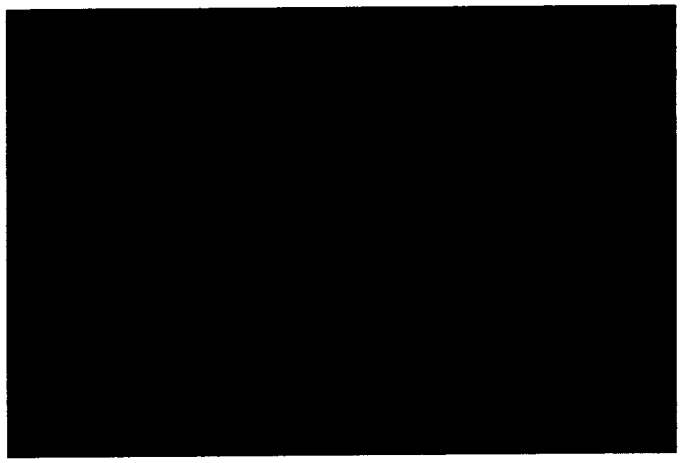


Figure OC-3: Colliding galaxies.

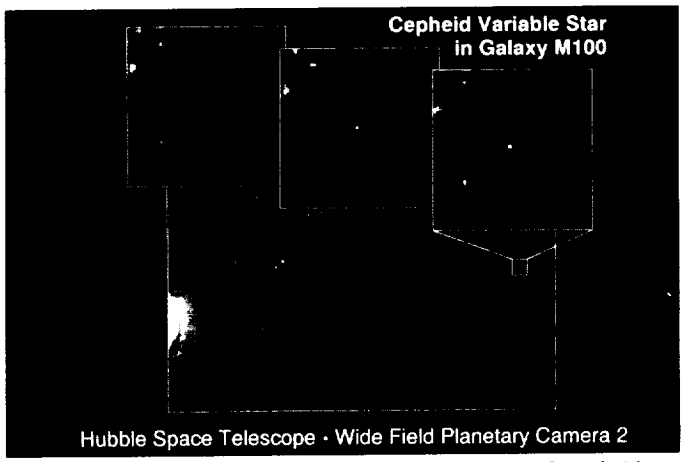


Figure OC-4: Hubble Space Telescope observations of Cepheid variables in another galaxy gives us clues to age of the universe

singular room is an auditorium, to which the press is invited for press conferences and NASA employees are occasionally invited to receive medals. It is here that once a month the administrator of NASA, Mr. Daniel Goldin, has been inviting leading scientists, theologians, historians, and other thinkers to discuss what would be a significant agenda for America's next era in space, an agenda that is both profound in its search for truth, compelling because of its far reach, and inspiring to the public. We are only a third of the way through this year-long exploratory process, but already we are starting to see a road map taking shape. It is unusual, perhaps unprecedented, for a federal agency to engage in anything like an intellectual dialog with itself and its customers—and to expect that that dialog will lead to a driving vision for the next century.

What are we learning? First, we find that our view of the universe has changed greatly in the last 60 years since Edwin Hubble discovered the recession of the galaxies, that they were all moving away from each other, that the universe was expanding and was 10 to 20 billion years old. His discovery was an incredible change in our worldview, a change as profound as the Copernican revolution.

We have a fancy name for a worldview, we call it cosmology because it deals with our myth for the origin and workings of the cosmos at large. At the time of Edwin Hubble, a half century ago, we believed that the cosmos was homogeneous, uniform, isotropic. But today, our worldview is undergoing another profound change. As a result of applying new large telescopes to the study of the universe—telescopes on the ground and in space—and techniques like adaptive optics, we have recently discovered that the universe is clumpy. Huge sectors of it are moving in specific directions because of gravity (*Fig. OC-1*).

With new, much more precise measurements, all of our cherished concepts and numbers are challenged. We have less confidence, not more, about the true size, age, and density of the universe, whether it will continually expand or slow down and will eventually close in on itself. We don't understand why the universe is clumpy, why there are galaxies and clusters of galaxies, why the radiation left over from the Big Bang that was its origin is so smoothly distributed (*Fig. OC-2*). We used to think that the galaxies were far apart from each other; now we appreciate that,

Figure OC-5: NASA's and ESA's Cassini mission will probe Titan for signs of life early in the next century.

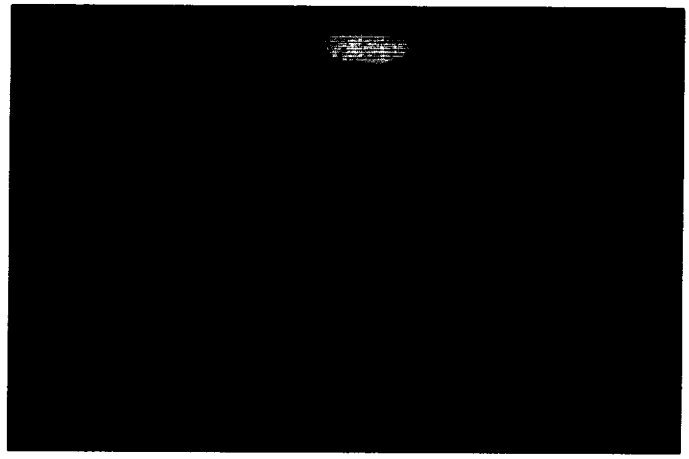


Figure OC-6: Hubble Telescope image of Mars

relative to the scale of the universe, they are so close that they bang into each other and produce weird shapes and patterns of radiation (*Fig. OC-3*). We recently discovered that the universe appears to be younger than the stars that fill it—a notion that hardly makes sense until you realize that, with all our new technologies, our measurements still lack precision (*Fig. OC-4*).

There are four numbers we would like to know: the amount of matter in the universe, the energy density of the vacuum that is space, the Hubble constant, and the transverse motions of the galaxies. These four measurements are fundamental to our understanding of the birth and evolution of the cosmos. Yet we are far from being able to measure any of these fundamental parameters well. We lack aperture and we lack baseline, and with out this, without extremely large telescopes in a stable configuration in space, above the Earth's distorting atmosphere, we cannot see beyond the local disturbances in the flow of galaxies, and we cannot measure precisely the tiny motions of stars in far-off galaxies. The Hubble Space Telescope is a great telescope, but a limited one. To do better, at an affordable price, we will have to find ways of building much larger, lighter telescopes, a constellation of them spread over a great area of the sky (or the surface of the moon) and carefully networked together to operate as one giant dish in space.

Second, we are learning about ourselves, what it means to be alive. If we are going to pioneer the solar system and beyond, it would be good to have a definition of what constitutes cellular life, and how we would recognize signs of life elsewhere. Surely the knowledge that there is life elsewhere, either now or in the past, would revolutionize our view of ourselves in the Universe. Trying to answer the question of whether or not there is life elsewhere used to be idle conjecture, but now we have the wherewithal to find out. We learned from our seminar speakers that one way to detect life is to look for organic molecules in samples and to look for a degree of complexity that could not arise by accident. We should look for a large number of equivalent molecules (on the basis that this would not be an accident) or polymers of a defined signature coming up frequently—in other words, look for *non-random* phenomena as a sign of life.

Where should we look for signs of life? Our experts favored taking samples from Mars and looking for fossil evidence of organic chemicals. Titan, the moon of Saturn, is another possibility, as is a comet, which is made of the material that was early Earth (*Fig. OC-5*). Some scientists make the case that life is a planetary phenomenon and grows exponentially under the right conditions. All our experts agreed that if you have the right environment, life will appear very quickly, and there is ample evidence on our own planet to show that this is true. There are, after all, 30 million species on our planet, some with origins 3.5 billion years old. Interestingly, RNA sequencing shows that there is only one form of life on Earth; we are all made of the same stuff. Our common ancestor, we learn from the experts, was a thermophytic sulfur bacterium!

The particular abundance of elements on the Earth is its signature of life, cell biologists and chemists argue. Earth differs from Mars and Venus in that it has more oxygen, nitrogen, and water, and less carbon dioxide—and Earth is at room temperature. They point out that it is nonhuman life that has changed our planet, that organisms regulate the planet and have made it what it is for 3,000 million years; these organisms removed carbon dioxide and produced the large amount of oxygen we have. Life will grow and grow and expand, given only water and food to reproduce. These organisms have made the air and soil suitable for human life.

On any other planet that has signs of life we should expect again to find life as an integrated, whole planet system. This requires carbon, nitrogen, sulfur, and water. The search for life on other planets is

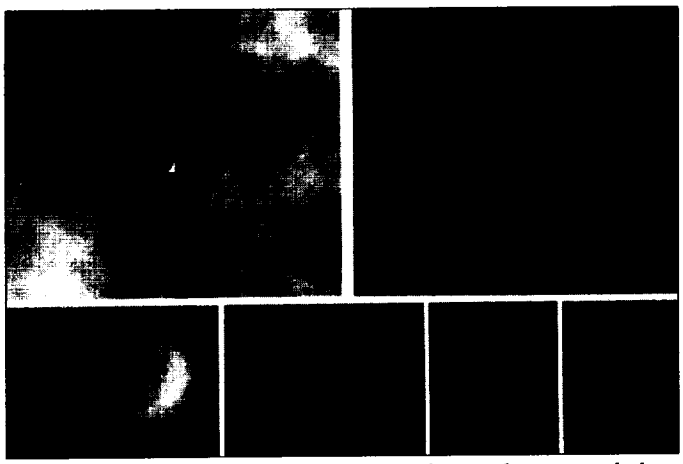


Figure OC-7: Hubble Telescope images of protoplanetary nebulae

equivalent to searching for liquid water. Our task should be to measure the surface temperature of planetary bodies at microwave wavelengths to see if there is
liquid water. Mars could be habitable but isn't *(Fig. OC-6)*. It may have had liquid water in the past, but it's gone now. Mars is much smaller than the Earth. There are no active plate tectonics, and it can't maintain the dynamic interactions that Earth can.

Do we have to limit our search for signs of life to our own solar system? Do we have evidence of other solar systems? Our first real evidence that these probably exist came in 1983 with observations by NASA's Infrared Astronomy Satellite, IRAS, which discovered
infrared-emitting "fuzz" around the images of nearby stars. More recently the Hubble Space Telescope has imaged clearly a stellar nursery called the Orion Nebula and discovered that about 50 percent of the stars have disks of gas around them that could be solar systems in the making *(Fig. OC-7)*. With present technology, especially speckle interferometry, we could probably image Jupiters around other solar systems from the ground. With space technology, we could image earths orbiting other suns.

We have the beginnings of a road map. We have signs of life to search for, and we have identified places that could enable this exploration. On the Moon a wide, stable interferometer could be placed to image distant earths and to use as a jumping off point for Mars, where robots or humans will search for evidence of fossil life. An interferometer with large aperture. dishes could also be used to measure with much greater precision the vital statistics of the cosmos: How big is it? How old is it? What was its beginning? What is its end? These two explorations have a connection—ourselves: Why are we here? What is our purpose? Historians tell us that these are questions that ancient civilizations not only asked themselves, but built elaborate cosmologies to answer. Interestingly, the difference, for example, between their cosmologies and ours is that theirs were founded

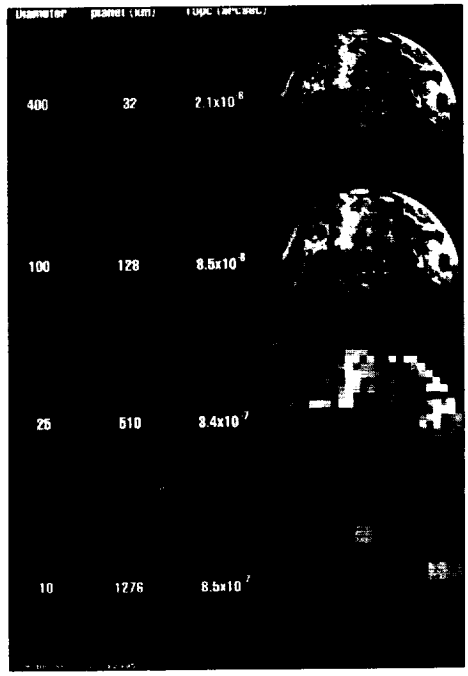


Figure OC-8: Dr. Robert Brown's computer-generated image of an Earth-like planet viewed at 10 parsec with different resolutions

on images with which every man, woman, and child could easily connect (take the Mayan metaphor of the Milky Way as a canoe), whereas ours are abstracted into numbers like omega, lambda, and H-naught.

Is this vision realizable? Can we hope, for example, to identify an earth orbiting another star? Or quantify the numbers that underpin our cosmology? Yes, it is! Right now scientists and engineers are forming teams to study the new technologies that we will need: nonlinear optics, hyperspectral sensors, adaptive optics, laser ranging, interferometers, methods for precise station keeping. It will take an integrated, multidisciplinary effort, but that is something that NASA is good at. Only NASA looks at the whole planet, not the separate disciplines of biology, geology, physics, etc., and it is this unified approach that we'll need to accomplish our ambitious goal. What is the challenge? Look at this slide *(Fig. OC-8)*. The technical challenge is great, but we see its possibility and you see its power.

Our dialog on NASA's next era in space is just beginning. Having looked at some issues in biology, planetary science, and astrophysics, we are now planning to take a closer look at the science of the Earth. We want to understand much better the impact natural and human factors have had on our planet. That's the motivation for our mission to planet Earth. It turns out that we know more about the sun—and some of the nearby planets, their atmospheres and chemistry and landscapes—than we do about our own planet Earth. Ironically, it was our voyages outward, to the Moon and the planets, that made us look at our own planet in an entirely new way. We had not

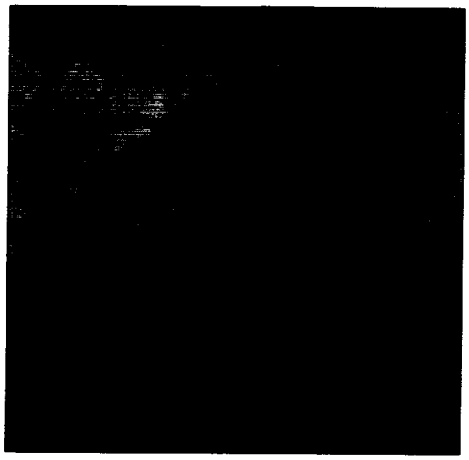


Figure OC-9

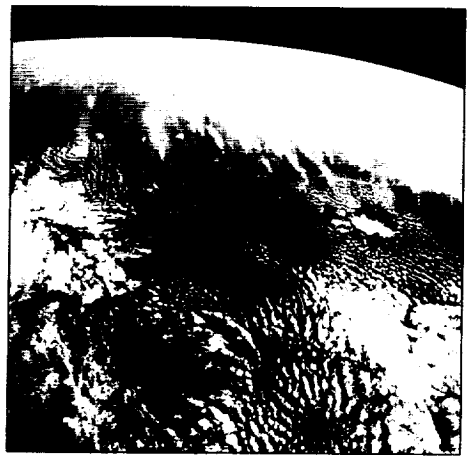


Figure OC-11

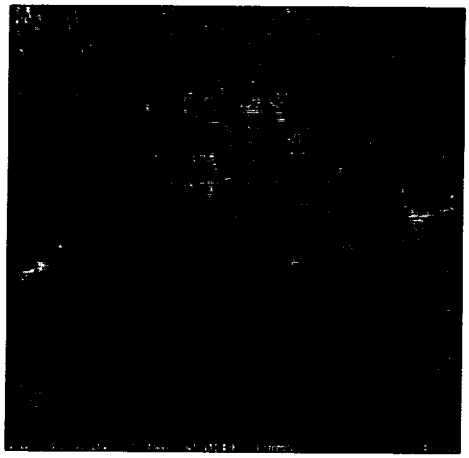


Figure OC-10

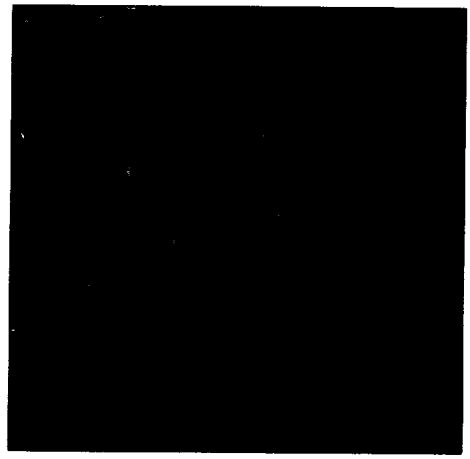


Figure OC-12

considered remotely sensing ourselves! Our view of Earth from the shuttle shook us up *(Figs. OC 9-13)*.

Our vision is that we learn to be excellent caretakers of our global backyard for future generations. To do this we will need to understand how all the parts are related to the whole. And this will require a vast information network. This slide *(Fig. OC-14)* reveals a world with a digital pulse, a world aware of itself.

And, finally, in our dialog through the remainder of this year, we will explore our own role in this adventure. What will human beings do in space? Perhaps we'll need human beings because we've always been adventurers, because we can make decisions machines can't and because we can do challenging space experiments that require the skill of a surgeon. Perhaps we need to involve machines that have consciousness, and that can live longer than a human life span. Our dialog at NASA will take us into the science of consciousness and the new technologies life and medical sciences are offering that may enable some progeny of ourselves, a mating of human and machine, to explore beyond our solar system.

To get ready to explore and utilize space, we use the space shuttle as a laboratory and, soon, we will enjoy the much longer duration laboratory capability of the Space Station. On planet Earth we are 5 billion astronauts on a space ship hurtling through space at 500,000 miles per hour. Our spaceship experiences precisely one "g." But we can alter gravity, one of nature's four forces, by going into space. This profound capability allows us to explore the natural world that we take for granted, including our own bodies and
common processes, in a much different way, allowing us insight into physics that are masked on Earth by the effects of gravity. On the shuttle we have investigated the behavior of living cells, fluids, proteins, and processes like combustion and phase transitions in a much reduced gravity. We've been encouraged by our successes and the interest of industry in this research. We envision that space is slowly transforming into the province of not just a few, but of many.

We hope that the end of our search for an integrating agenda in space will bring us a new vision of what is possible, and new ideas about the technologies we will need to achieve this vision. We want it to be a distinctly human vision, one that satisfies a need that is deep in the psyche of most of us. We want to leave the legacy that a young

Figure OC-13

Figure OC-15

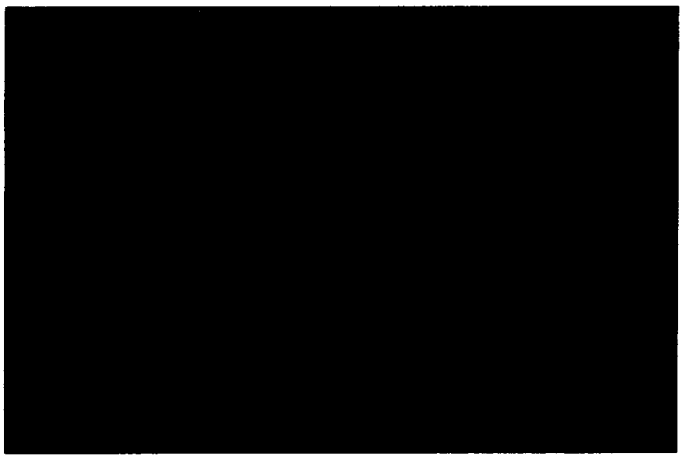


Figure OC-14

Figure OC-16

astronomer, Dr. Can Lester at UT Austin, talked about when he recently testified before Congress: "The heritage that we leave for future generations is not just knowledge of the scale of the universe, or evidence for black holes in the hearts of galaxies, but the spirit of exploration of the world around us. For it is this spirit of exploration, and the curiosity that drives it, that is one of our most profound national needs. A nation that stops exploring is a nation that cannot produce the scientists and technologists that we so desperately need to be competitive in the global economy, and to improve the human condition. Federally funded scientific research is a contract with the U.S. taxpayer not only to create new products, but to satisfy the national curiosity about the world in which we live. It is a fundamental element in the federal investment portfolio that ensures our leadership in the world."

I'd like to close by showing you this portrait of a cluster of galaxies *(Fig. OC-15)*. This is a multitude of Milky Ways, each the host of 10 billion stars. Ten billion galaxies in our Universe times ten billion starts in each—and yet we know of only *one* solar system and only *one* life-bearing planet *(Fig. OC-16)*. To view ourselves, our home, from a remote suburb in space—and to view the evolution of the Universe back to nearly its origins—these are remarkable capabilities that empower us to continually renew our view of our own purpose on this planet and our final connection with the stars.

We hope that the end of our search for an integrating agenda in space will bring us a new vision of what is possible, and new ideas about the technologies we will need to achieve this vision.

Acknowledgments—Thanks to our "space visionaries" who inspired this talk and provided ideas and materials: Robert Brown, Anneila Sargent, Chris McKay, Lynn Margulis, Leslie Orgel, Vera Rubin, Bohdan Paczynski, Linda Schele, and, especially, Daniel Goldin.

Visions for the Future

Master Moderator: **David L. Payne**
Manager, Spacecraft Technology
TRW Space & Electronics Group

Speakers:

Dr. Moira Gunn
Producer & Host
TechNation...Americans and Technology

Dr. Edward Teller
Director Emeritus
Lawrence Livermore National Lab

Lt. General Jay W. Kelley, USAF
Commander
Air University

Dr. Peter G. Neumann
Principal Scientist
Computer Science Laboratory
SRI International

Dr. Hans Mark
Professor of Aerospace Engineering
and Engineering Mechanics
University of Texas

Dr. Buzz Aldrin
Apollo astronaut, space pioneer and futurist

MR. PAYNE: Welcome to the United States Space Foundation's 11th National Space Symposium. I'm Dave Payne and I'll be your program moderator over the next three days as we explore this year's theme of Vision and Reality: Face to Face.

Since before recorded history the human race has looked toward the heavens for inspiration and hope. Today we find the promise of space has become reality as increasingly we find more and more practical applications of space to improve the human condition and expand our knowledge base. So, where do we go next? Over the last 11 years the U.S. Space Foundation has sponsored this, the National Space Symposium, to bring together the leaders of the world's major space organizations. This year's symposium is no exception. We have gathered an unprecedented assembly of the earth's space-faring leaders. Today and for the remainder of the week the sessions, forums, and exhibits here are designed to provide you with visionary insights into the future and examine the means to make those a reality.

Today we find the promise of space has become reality as increasingly we find more and more practical applications of space to improve the human condition and expand our knowledge base.

It is my great honor to serve as this year's program moderator for this premier space symposium here in beautiful Colorado. We have a full and exciting agenda this morning, and the session moderators and I will make every effort to hold to our tight schedule. I will have the hook ready at all times. So, join us on our odyssey as we examine Vision and Reality: Face to Face.

To kick off our symposium, we are very fortunate to have Dr. Moira Gunn who has been the producer and host of *TechNation* since 1987. *TechNation* is a one-hour weekly public radio program which features conversations between Dr. Gunn and guests who represent the past, present, and future of technology and evaluations of its impact on our lives. This highly successful program has spawned a series of public television specials that are currently in production, and we are fortunate today's session will be among them. Dr. Gunn is a former NASA engineer and scientist, who specialized in robotics systems and also software development for large scientific applications such as global weather and climate modeling and earthquake modeling and prediction as well. She's an adjunct professor at the University of San Francisco and holds a Ph.D. in mechanical engineering and a master of science in computer engineering from Purdue University. Please join me in welcoming Dr. Moira Gunn.

DR. GUNN: Thank you and welcome to *TechNation...Americans and Technology*. Today is a special broadcast and that means that we all together are in that broadcast. First of all, it's both televised and on radio, and it can be heard over a number of venues including NPR stations and PBS nationally, Armed Forces Radio and television internationally, as well as Internet multi-casting and video services all throughout the world. But the problem with any of these broadcasts is that unless you are at the right place at the right time you don't get to hear them or

see them. So, if you would like to have either a video or audiotape of this session, we have arranged through the U.S. Space Foundation to provide that to you at cost. So you don't have to be searching all over the place. This is a live taping before a studio audience. First of all, during the opening of the show we will need some applause at various times; we'll have some cues now and at the end as well.

Live from the National Space Symposium in Colorado Springs, I'm Moira Gunn and this is *TechNation...Americans and Technology*. I'd like to welcome my guests today, in alphabetical order: Apollo astronaut, space pioneer and futurist, Buzz Aldrin; commander of the Air University of the U.S. Air Force, Lt. General Jay Kelley; former deputy administrator of NASA, former Secretary of the Air Force and currently a professor of aerospace engineering and engineering mechanics at the University of Texas, Dr. Hans Mark; long-time moderator of the Internet forum on computer-related risks, and principal scientist of the computer science laboratory of SRI International, Dr. Peter Neumann; and last, but certainly not least the director emeritus of the Lawrence Livermore Laboratory, Dr. Edward Teller.

Gentlemen, thank you so much for joining me today. Now, it seems to me that the funding for space exploration was fueled by either a stirring vision, like the race to the moon, or a fear of threat such as the Cold War. Lacking either, what are the major factors that seem to be affecting space funding today, and given the real and inherent risk of such programs, how much does the specter of risk affect that funding? Dr. Mark, if you could start.

DR. MARK: First, I would argue that there is still a threat. The dominant trend today is the proliferation of high technology weapons including nuclear weapons and launch vehicles around the world. Therefore, the reasons related to national security and, more importantly, world security now for going into space are still there. I think they will still be the dominant reasons for developing space technology. Risk is inherently part of this; one has to make judgments and guesses that hopefully are right, but I believe that the eventual creation of space-based defensive systems on a worldwide basis is the most interesting prospect. If you go to Europe today, people are concerned about threats from North Africa; for example, missile threats. These are things that will be done in the coming years and that I think will continue to be the dominant motivator for doing new technology in space.

DR. GUNN: General Kelley, as the leader of the Space Cast 2020 study, you must agree with that.

GENERAL KELLEY: Well, not exactly, Moira. We need to add a little controversy. Certainly a stirring vision and fear are great motivators. They always have been, always will be. But in today's environment I'm not too sure that they are the principal motivators. Seems to me Joe-Bag-of-Doughnuts and his cup of coffee standing in front of the Seven-Eleven is more concerned with his quality of life. And if Joe, with his cup of coffee, doesn't understand what space activities do for him and his way of life, I'm not sure he's going to be interested in getting too deeply involved. So down at Air University I think a lot about that. We thought a lot about that at Space Cast 2020. We thought about it from the perspective of education. The U.S. Space Foundation is deeply involved in working that problem specifically. We noticed in Space Cast 2020 that if we accomplished nothing else, if we didn't identify one single gadget, gizmo, or doodad that did magnificent things, we were going to have educated 120 Air Force, Army, Navy and Marine Corps officers about space more than they ever dreamed in their lives. To go back and drive tanks, drive ships, fly airplanes with a different perspective of what space could do for them. So I think education and helping people understand what space can bring to them is perhaps a more important stimulus today.

. . . the reasons related to national security and, more importantly, world security now for going into space are still there. I think they will still be the dominant reasons for developing space technology.

DR. GUNN: Now Buzz, what do you think?

DR. ALDRIN: This is not controversy. I agree with both of these gentlemen.

DR. GUNN: Then never mind.

DR. ALDRIN: However, having been there I think there are a few other people in addition to Joe-six-pack who might want to dream about wanting to get there sometime in the future. And that says we have to look beyond our nose; we have to look beyond just the short-term objectives that may motivate our legislative people who allocate the funds. We have to look beyond the next 10, 20 years, a generation, a few generations of evolutionary vehicles. I think it has to move in the direction of one day when there will be tourism in space. The vast billions of dollars that are spent on people enjoying once-in-a-lifetime opportunities. It will come, I'm sure, and space will be a part of it.

DR. GUNN: Dr. Teller?

DR. TELLER: There is a reason why I hesitate to become a space tourist. On my mother's 80th birthday, there was a great activity. People went all around the world in space, and my mother exhibited an unusual interest in this technology. I did not know why. And when they finally were all safe, she turned to me with a sigh, "But you will never do such a thing."

Also there are many things other than tourism that we have to do. Defense is very important. Looking at the Earth, we shall be able to understand the atmosphere and predict weather for two weeks. The rewards are enormous.

I don't know how many of you know about the small object that was looking at the moon, then it was getting away and gone forever. For that reason it was called Clementine. It took almost two million pictures of the moon, and we now have as good a geography of the moon. I don't see how people can fail to be interested in all the peculiar things that we find. These are exciting things that do not correspond to people's immediate appetite for knowledge, but I predict that this appetite will grow with the eating.

DR. GUNN: Now let me ask you, let me take another little turn here, because we'll come back to funding. I'm very interested in looking at what we're doing in terms of humans in space, the risk that's involved, and how that's going to be affecting them. Peter, can you start to talk about humans and risk and that kind of thing?

DR. NEUMANN: Good. The first question here when we're talking about outerspace is, of course, innerspace—what's happening on the planet. As we try to develop systems that have very high requirements for reliability, human safety, security, whatever, we find that there are tremendous innovations that are emerging from the programs that NASA has undergone in the past years, but there is still a lot that's left to do. One of the risks is that we need to keep up not only the education, because our future really depends on our young people and older people who are in need of retraining, but also the issue of research. There are problems in dealing with complexity in very large systems that must be dealt with very explicitly, and I think this is something that we have to look at: What are the risks is certainly one of the questions. But, how do you build systems that will avoid those risks? This a very, very difficult problem we've spent years on in the research community, but there is still a lot left to do.

DR. GUNN: Dr. Mark?

DR. MARK: Let me talk a little bit about risk. I was involved in the first launching of the space shuttle Columbia and then presided over the next 13 launches. We had yesterday the Apollo 13 event, and I was on the accident investigation board for that flight back in 1970. I have, therefore, a little bit of acquaintance with the business of risk taking. About 20 years ago I had a conversation with Werner Von Braun about this subject, the subject of the risk of sending people into space, and he drew an interesting analogy. He said that what you have in the case of space exploration is already something we've had experience with on earth, namely the exploration of Antarctica. This was also a very risky enterprise in the early years of this century. He put together a time scale on how things happened and he said, "Look, the Amundsen expedition to the South Pole was December 1911—the equivalent of that was Buzz Aldrin's first trip to the moon in 1969." He said it took 30 years to really develop the technology to go to Antarctica and the key enabling technology was airplanes. Lincoln Elsworth and Richard Evelyn Byrd made it possible for people to occupy Antarctica by demonstrating that you could operate airplanes there. He then said, "You know, 20 years from now tourists will go to Antarctica." I want to pick up on that tourism, Buzz. Three years before my father died at the age of 97, he actually went to Antarctica on a tourist ship. That was in 1991, so that's 80 years after 1911. Buzz, I would say that we will have tourists on the moon in the year 2050, 80 years after your first trip to the moon.

Buzz, I would say that we will have tourists on the moon in the year 2050, 80 years after your first trip to the moon.

DR. ALDRIN: Without a doubt.

DR. MARK: And the risk will be reduced by the introduction of new technologies, as you say. Start with very high risk operations, and you get to the point eventually where tourists go, and I'm convinced that will happen.

DR. ALDRIN: I don't think they have to go that far to have a real treat. Zero gravity for a period of time, looking down on the Earth—some of those pictures that were put in IMAX of approaching Gibraltar and seeing the Mediterranean. Imagine in real life to be able to witness that sort of a view, not just within the theater.

DR. TELLER: I like to do what my mother tells me to do, and even not to do what she tells me not to do, which is more difficult. I think to go into space is an expensive business and will not become very cheap very quickly. On the other hand, we have an enormous development of electronics, of computers, and therefore the jobs that have to be done can be done, in practically all cases, near to the Earth by electronics,

computers—without people and, therefore, without any risk of life.

When you go to the moon you have enormous possibilities like, for instance, use the moon as a refueling station. This will be complicated enough so that people will be needed. I hope that these very important jobs will get done. What are we spending on space? Twenty billion dollars a year. . .

DR. MARK: A little more.

DR. TELLER: . . .and we should spend much more—but we should spend it where it pays off. Hans, I fully sympathize with my old teacher and your father Hermann Mark. I *do* want to go to Antarctica; I will not go to the moon.

DR. MARK: Let me add that some of the most important spin-offs in our technology have come out of the space program. And I think it is again very important that we keep up an awareness of the big picture. The big picture says that we need to do a lot for the people on this planet, whether it's commercial aviation, which almost gets neglected in a lot of the discussions or aeronautics generally, or whether it's science education or education at large. I think we also want to make sure we're not only looking at what can we do with Mars or the moon. Let's also keep an eye on what's happening here.

DR. GUNN: Well, you know, I find it's sort of a hard sell to say space has been good to you because of the offshoot of technology. This is good, science is good, this is interesting. I think Joe-Bag-of-Doughnuts says, "Who cares?" But Gen. Kelley, if we spent 10% of our budget on sending a whole bunch of Joe-Bag-of-Doughnuts into space, so they've got their ride, do you think that the 100% of the budget might be a lot bigger?

GEN. KELLEY: Could be, depending on the experience. Let me take a slightly different track on this thing, from a military point of view. We took a look at this in a little study we did. Surprisingly, of all the interesting things, concepts, ideas that we've identified looking into the far future, there's two things: sometimes when you do a study, it's important what you find and then what you don't. What we did not identify was a requirement for a military man or woman in space through the far future. Did not. We've got a lot of sensory capability through machines, generally machines, that do it pretty well. So, what's the overriding reason to have a military man or woman in space? I don't believe it's a trivial question. When you go to space, there's mortal risk, so too on the American highway, but new venture is risk, money. Anytime you try to drive risk to zero because you're a little concerned, you drive the bottom line where? To the red. So, how much is it worth, America? And that's what we've got to engage and that's why I'll come back again to what I stated earlier; education's important. If Joe doesn't understand, if he can't identify with what we're doing, he's going to have trouble supporting it. And so the U.S. Space Foundation, every college and university, like Dr. Mark's operation down in Texas, what we do for the military profession, Air University, we've got to help the war fighter, we've got to help Joe-Bag-of-Doughnuts, we've got to help America understand why this is an important risk to take.

DR. NEUMANN: An interesting sideline is that Joe-Bag-of-Doughnuts in the emerging world, which is so technologically dependent, is going to have to have a much deeper understanding of the technology then he ever has before, simply to survive.

DR. GUNN: Buzz?

DR. ALDRIN: Well I've been a military person; I've been associated with the Air Force. I've observed that occasionally it changes its mind over a period of years. I remember a Dyna Soar program that had a human in it, I remember a Blue Gemini, and an MOL, I remember well. And in each case there was a program and then there was no program, and then there was a change, manned space flight engineers, launches of shuttles from Vandenberg. Let me just question whether Black Horse is going to be operated by a robot. We're going to need policemen to monitor what does happen in space, in security, in customs. Maybe we can do all these things with robots and little cameras, but I think we're going to need some military people eventually to pave the way, and they're going to be involved. I just came from a fighter squadron reunion and those guys want to be a part of this, with their children.

DR. GUNN: We want to be a part of it; I want to be a part of it. I'll go. I want to go, but when should we be using and how should we be using humans in space?

DR. MARK: Let me answer that, because again, I've personally been in a position to make such trade-offs. If you talk about Dr. Teller's question of using the moon as a cosmic gas station, that depends on finding hydrogen there, or water if you will. You find that either as ice on the surface—and by the way, the water comes from bombardment by comets, that's the source—or you find it as hydrated rocks that one might look for. I think if you're really going to thoroughly look for fuel on the moon, you have to send people. It's too difficult to do that robotically, because you just can't anticipate what you'll find. You could make some preliminary explorations, but in the end you're going to have to send people back to the moon and drill into the ground and really look.

Let me switch subjects for a minute. We haven't talked about making money on space. Three years ago, a friend of mine came to me after the end of the Gulf War and said that after every war somebody figures out ways to make money out of it. "What is it in the Gulf War that has happened that should change things around?" he asked. And I kind of blurted out that GPS was, of course, decisive.

DR. NEUMANN: The chocolate that survives 140 degrees.

We have created hundreds of jobs in the past three years on some fairly simple applications of GPS, and we're going to make money.

DR. MARK: No, not that. But, we organized a company three years ago to use GPS to manage fleets of maintenance vehicles that the telephone company runs, that cable TV companies run, and now we're selling it to power companies. We've already sold about four or five thousand of the things we make. We have $50 million worth of orders. Now, Joe-Bag-of-Doughnuts works for us. We have created hundreds of jobs in the past three years on some fairly simple applications of GPS, and we're going to make money. We're going to have a company that will be large. We'll go public. I think that's going to happen more and more as space systems become more available. I think Iridium, for example, is another one that is going to become very important. (Iridium is a worldwide cellular telephone system using many small satellites. It is being developed by Motorola.)

DR. GUNN: Well, I think Joe-Bag-of-Doughnuts sees the end, sees the final result when it's finally here and he gets his job. But, this has to start with funding. It has to start with some federal funding here, and that's the problem. How do we start it?

DR. MARK: The funding still comes from the threat.

DR. GUNN: It's the threat. Not a stirring vision. Yes, Dr. Teller?

DR. TELLER: What shall we establish on the moon? A fueling station. Yes, really to do it people will be needed, no question. But, a little point: Clementine has found something peculiar on the moon. Near its south pole, there is a big region, more than 100 miles by 100 miles, a deep old crater. It is almost precisely at the south pole and the moon is almost precisely perpendicular to the ecliptic. The bottom of that crater may not have seen the sun for a billion years. That means that those comets or whatever hit will stay there. Clementine was a cheap project that cost altogether $80 million, a very small fraction of the $20 billion we are spending on space. It has already given evidence that the place to find ice on the moon is on the south pole.

DR. MARK: The place to look is on the south pole, and I would submit that the evidence is not very strong yet. One really has to go back to the moon, one has to go back with better instruments, and eventually one has to go back with people.

DR. TELLER: What is your bet? I'm going to bet one-to-one that you find ice there. Not a certainty, but it's not a thousand-to-one, it's not a hundred-to-one, it is one-to-one.

DR. MARK: I won't take the bet, because I think we'll find it too.

DR. TELLER: Now another point. I agree with you also on the need of a threat, but I claim there is no shortage. And I do not mean the threat from North Africa to southern Europe. I agree that's important, very important, but there is the threat of being hit by one of those comets. The last time it happened was in Siberia, the Tunzuska meteorite. I was then six months old—in 1908. It exploded above the ground, an explosion of 10 million tons TNT equivalent. Had it happened in a populated region, it would have been a big disaster. We have excellent reason to believe that this is a disaster that, with appropriate notification, can be averted. Here is a threat that is less probable than most other threats, but when it happens, it can become enormous. Sixty-five million years ago the dinosaurs were killed. The whole population of the Earth changed. That I think is a very interesting threat that can help to unify the world's efforts. Nations could work together and thereby avoid unnecessary threats.

DR. GUNN: It looks like the NASA budget is going to get cut. It looks like it's going to stay cut for awhile. Given what we have—what resources we have—what do you think we ought to do? Buzz?

DR. ALDRIN: I think we ought to preserve the objective of human permanence in orbit. Whether it's the present international space station that brings together the two former conflicting partners, the Russians and the western powers, or whether it's something we have to back off from, we should have something up there that we can go up and visit and occupy. Maybe in a temporary way, maybe permanently. So, whatever Congress does, I think we have to preserve that and a progressive means of supplying those assets in orbit.

DR. GUNN: How about you, Dr. Mark?

DR. MARK: I think first we have to straighten out some management problems in NASA. I like the move now to take the shuttle off the civil service payroll and put it into a single contractor and then perhaps even begin to privatize it. You know, we did that back in 1962 with communication satellites. We set up a government-sponsored corporation in 1962. The government had 51 percent of the stock, then AT&T, RCA, IBM, and, I believe, Western Union. In 1969, seven years later, the government pulled out and we had a commercial enterprise. I would suggest that the shuttle be organized, and all other launch vehicles, by the way, be organized somewhat the same way and that's, I think, one management...

DR. GUNN: A priority of forging a commercial link...

DR. MARK: Well forging a link, you can't make the shuttle a profitable enterprise, or any other launch vehicle, any big launch vehicle, but little ones you might be able to at the moment. But you can move in that direction; you can bring in people who know how to commercialize things, and we in the public sector don't generally quite know how to do that.

DR. GUNN: Looking at, from your viewpoint, what you've been studying and the great joy of spending other people's money, what would you think, General? What do you think NASA ought to do?

GEN. KELLEY: In our little work down there at Air University, we tried to look at a set of alternative futures. One of those was called a space-faring world, a very high technological, economic activity, a lot of people playing in space, a lot of strong will by all countries involved to be in space. And we strive to say, "How do you make that happen?" Because we learn from many people, if you can create a vision of a place that people want to be, they're going to try to do that.

How many of us in this room remember back when we were little kids growing up, in what I would say were still the early days of air power, what did you do as a kid if you were interested in airplanes? You went down to the local big airport and watched them land and take off. I used to do that from Indiana, going down to Indianapolis. You look around today and you don't see people doing that very much. Where do they go watch things happen? NASA, Cape. We need to change, in my opinion, a little bit about our attitude, 'cause air power moved on and we need to get the space business moved on. To me it's not helpful that the only way this great nation gets to space is from two pieces of concrete in Florida. Or maybe a couple out in California. We need to be able to go to space from Garden City, Kansas.

We need to be able to go into space that way, down a runway of any reasonable length, anywhere in the country rather than this way. And I think that if we can move to that, we can do a lot of good things for America, and get America involved. An F-16 is very sophisticated. So is the B-1 and a B-2 airplane, and we maintain them with well-trained high school graduates. And we fly them with well-trained college graduate history majors. We need to adopt that kind of philosophy in our space business and from a military perspective, that's different. I think if we can do that, we're going to get more of America behind what this country is doing in space.

To me it's not helpful that the only way this great nation gets to space is from two pieces of concrete in Florida. Or maybe a couple out in California. We need to be able to go to space from Garden City, Kansas.

DR. TELLER: I have a little suggestion concerning how to do things. Of course, I agree, the more we can bring in private enterprise, the more reasonable we are apt to get. But, even from the present point of view, more electronics, more computers, more technology all point in one direction. We can do near-Earth jobs, like looking for the weather and many other things, without man, without terribly much expense, with small satellites. The emphasis on small satellites, where the launch will cost not much more than a million dollars, where the satellite might be not much more than 100 pounds, maybe 200 pounds. This is the way to be allowed to make mistakes and learn by them. If you want to send man, if you make big satellites, then whenever you make a mistake you pay for it dearly.

Now I want to quote the greatest physicist of all, Niels Bohr. He gave a definition of an expert. An expert is a person who, through his own painful experience, has found all the mistakes that one can commit in a very narrow field. If you don't make mistakes, you don't learn. If you only do big things, you can't make mistakes.

I support exploration and continued investigation of the small unmanned objects near the Earth. What will we get out of it? All kinds of things. But to my mind one point stands out. Today we are terrified of everything. We are terrified of too much carbon dioxide in the atmosphere. We are terrified of vanishing ozone. We are introducing all kinds of regulations, which have been estimated to cost us more than $100 billion a year. And all this is being done on incomplete information. The small satellites could help us to become much more reasonable and be worried about

the environment only in the very important cases where you have to be worried and not to be worried unnecessarily.

So, I am for high technology with small satellites and to use it to learn more, particularly about the environment and where we have really to worry about it.

DR. NEUMANN: Many people have commented, and Henry Petrosky is the one who gets quoted for it most often, that we don't learn from our successes. We only have an opportunity to learn from our mistakes. I would like to make a very strong plea here for the very, very small percentage of the budget that goes into research. If we are, in fact, cutting dramatically everywhere, some fraction of one percent is going into research. Research is the tail that wags the dog; it is a very, very long cycle—years in the pipeline. Some of the things that we were doing in the research labs 25 years ago are now emerging into fly-by-wire aircraft. Some of the redundancy management, for example, is extremely critical. Hans and I were talking before, in many systems half of the complexity is due to the redundancy management, trying to create reliable systems. This greatly increases your risks, and you need to do something about it. So, I would mention some work that's going on at NASA Langley Research Center under Ricky Butler, which is the formal methods and mathematical representation of some of these problems, and really serious evaluation of whether these systems that you might want to develop would work. You can demonstrate this long before you ever build the system. I think research of that nature is absolutely critical here.

The small satellites could help us to become much more reasonable and be worried about the environment only in the very important cases where you have to be worried and not to be worried unnecessarily.

DR. GUNN: Now, Buzz, I was noticing you when the General was talking about many different launch platforms. It seems that intrigued you.

DR. ALDRIN: Yes, I think there's a very safe launch platform. It's a subsonic airplane that uses the technology that enables people to travel millions of miles, and the failure rate of airliners is one in 10 million. That's the kind of reliability I think that may be involved in launch platforms. We can get up to a region where we're above some of the denser atmosphere, and we can drop a rocket that's a little bit smaller that may be in its process of accelerating. It can go supersonic with a rocket and then use ram jet air breathing to increase the efficiency. We may be able to take off some of the Black Horse airplanes with a very large wing aircraft and have it attached to the very large aircraft when we're doing the refueling of the Black Horse.

I think we need to look at all of the things that are going on and combine them. There's a launch platform that's being looked at now by a company that floats on the ocean. It can be based somewhere, take the rocket out somewhere, and position it where eventually, maybe, whatever that rocket is. The one I'm thinking of happens to be of Russian origin, Russian and Ukrainian origin. But down range from wherever that launch sight might be might be a good place to recover some of the first stage parts of it as a building block toward more reusability. I want to really make it a point. If we're going to decrease the cost of getting to orbit, we're just going to have to get into reusability. But I don't think we have to get into reusability in one fell swoop. To have a national launch policy that says one part of our government ought to concentrate on expendables and upgrading that and the other part of our government ought to look at reusables and then to watch that part of our government exercise the reusables in the most difficult way, the single stage to orbit (we may do that one day), but that leaves a big gap right in the middle and that's the reusable booster. Until we face the facts and start developing reusable boosters, stage by stage, I think we're destined to have way too expensive a launch system.

DR. GUNN: If we were just to do that, how much more over NASA's budget, how many times NASA's budget would we need to fund something like that, truly?

DR. ALDRIN: All you'd need is to assist the private industry with some of the technical problems. Build the next version that tests the fly-back nature of booster rockets. Make that an X- program, instead of an X- that wants to do everything. We have an X-program by NASA right now, X-34, a small reusable. Why don't we have medium reusable?

DR. MARK: I'd like to endorse what Buzz has just said, and add one point about where you get the money from. I've told you about our little company. We depend entirely on a public investment called GPS. We wouldn't be there if it weren't for that. We ought to be taxed (I'm a director of the company, don't tell anybody) for the privilege of using GPS and then that money ought to be spent on the kind of things that Buzz was talking about and the kind of things Edward was talking about, the network of satellites to do environmental monitoring. I remember in 1982 we started a program called Global Habitability, where we proposed precisely that and it got shot

down at the time because we were still in the Cold War. We went to a U.N. meeting in Vienna, I remember, and the Soviet delegate got up and said you are just going to build spy satellites and we don't want to have anything to do with it. So we had to shelve it. But the Earth observation system we're proposing today is very, very similar to that. We've resurrected the old documents and are doing that now.

DR. GUNN: So, the concept of the companies that benefit, part of their profit is fed back into the program?

DR. MARK: Of course. Absolutely.

DR. TELLER: There are two enormous developments. One has been already mentioned—better technology, better electronics. I don't know how much better it is than 20 years ago. I almost would believe it's 100 times as good. That is one reason why we can get much more information from space.

The other reason is what Hans now mentioned; it is a very important point. The peace in the world, the non-existence of the Soviet Union, makes international cooperation now possible.

The lesser expense on electronics, the better cooperation between nations, should make it possible to do very, very much more in the next few years. All of the things that have been mentioned, I would endorse, except possibly what my mother told me not to do.

DR. GUNN: Well, in terms of just humans, how far away should we go? Do you all agree we should go to Mars soon?

DR. MARK: We've talked about a lot of things. Let me talk about vision just a little bit. Between 1952 and 1954 *Collier's* magazine published a series of articles talking about the human race going into space. It was put together by a group of people I can't remember. I know Werner Von Braun was involved, Joe Kaplan from UCLA was involved, Fred Whipple the astronomer, and there were a number of people. The articles were put together, edited, by the gentleman who later on wrote the books about World War II, Cornelius Ryan. But the gist was that there was a series of steps that we would take: go into Earth orbit, build staging bases in Earth orbit, go to the moon, build reusable space ships (space taxis they were called), and build winged rockets. They were all in that article 45 years ago. We would then make a trip to Mars. I think we are still executing the plan that was laid out, the vision if you will, that was laid out in those articles 45 years ago.

DR. TELLER: But we did not do one thing 45 years ago. We did not emphasize the most important of all, small satellites.

DR. MARK: But we didn't know how to do it at the time, Edward. I'm sorry.

DR. TELLER: And that is why we should have thought ahead about what would be of the greatest benefit. Now, we know how to do it, but I claim a very recent discovery. I have discovered the most inert substance in the world—that's the human brain. What we did not plan 40 years ago, we cannot think about today. We did not do it 40 years ago. We should urgently think of small satellites so that 40 years from now we should do them well.

DR. GUNN: Buzz, do you think we should go to Mars? Fast?

DR. ALDRIN: Methodically, and in a very determined way. After the experiences of Apollo, when we go to Mars I think we should go to Mars in a sustained, growing fashion and not go, with humans let's say, once, twice, three times and then find that, O.K., we've done that so let's pull back for awhile. That's too big a venture to not do in a gradually increasing way. We should have sustainability in mind when we think about going to Mars.

DR. TELLER: That is where we were very wrong. We did not do it on the moon. And you are now telling us not to make the same mistake on Mars.

DR. ALDRIN: But it was not a mistake going to the moon at the time we went there.

DR. TELLER: It was a mistake pulling back.

I think we are still executing the plan that was laid out, the vision if you will, that was laid out in those articles [*Collier's*] 45 years ago.

DR. ALDRIN: Well, that's a question of affordability. I think the cracks that were begun in the Soviet empire, by the bitter disappointment of our getting to the moon first, began to fracture that threat.

DR. GUNN: Well, how much must the U.S., because of its space program today, and the funding that is available, it's required by the U.S. to take the lead. How much is possible on an international basis?

DR. NEUMANN: I think a good deal. We started the first space program jointly with the Soviet Union back in 1970 when we started flying American payloads on Russian satellites. They were biological payloads. We put together, we've flown about a dozen times now

and I remember, even with all the ups and downs we've had with relationships with the Soviet Union, we kept that program going. In the case of the space station, when we started that in 1983 and 1984, that was an international program. In fact, President Reagan went to the London economic summit in June of 1984 with a model of that space station, and he invited all the allies at the time to contribute, which they did. I think the step to use Russian equipment on the space station is a very positive one. I don't think it's going to save us much money, but I think it's a good thing to do from the point of view of unifying efforts in the world and using space exploration as a way to do that. The international things have been expanding and expanding properly. There's also competition, which I think is good. I think the competition in launch vehicles is a good thing; it sharpens everybody. I think there is a growing international effort here, and I suspect that we may be second in some of the things that are going to be done in the future.

I think the step to use Russian equipment on the space station is a very positive one. I don't think it's going to save us much money, but I think it's a good thing to do from the point of view of unifying efforts in the world and using space exploration as a way to do that.

DR. ALDRIN: I think the United States should encourage and support the European development of a crew transfer vehicle. We can't afford to do that, and I don't think we want to upgrade Soyuz, but a crew transfer vehicle that the Europeans may develop to be the next generation ought to also have the capability of being extended to be the first human container that can make a direct landing on the moon and return. So there ought to be that kind of growth. We can't do it all in this country, but I think we should distinctly encourage other international efforts and not look on them as competitive.

GEN. KELLEY: A related subject that's come up several times. We've all talked about the exquisite developments that are going on in terms of observing this planet, both militarily and environmentally. One of the things that I think perhaps is not advancing at the same pace is, what do you do with all that information? Where does it go? How do we use it usefully? In taking care of the planet and, from a military perspective, how do I as a military man use that? Today we in the military environment talk a lot about C4I, C3I, command, control, communications, intelligence, and computers. Now the first word in that little phase is command. We have a structure that's based on getting the command down, and I'm not sure that we have a structure that's as well suited to getting information, in the form that I need it, that's useful to me, when I need it. I think there's much more that we could do as a nation to more productively use the information that these exquisite objects on orbit can provide us. And we are not making as much use of that as I believe we should be.

DR. GUNN: We are talking about vision, and I would like to ask each of you... Dr. Teller?

DR. TELLER: There is one thing we did not talk about. I think we were right not to talk about life on Mars or elsewhere. Yet, I think also we were wrong. Probably, there is nothing of that kind. But we know that there were indications of life on Earth almost four billion years ago, from the very beginning. The traces of that were hard to find. If we could find any traces of life anywhere in our solar system, that is one of the really big things.

Second point. We talked only about the solar system, but there have been some ideas, some discussions, that go much farther. I want to make one simple statement. We will not do it without the priority, we will not do it with man. We shall do it in an unmanned fashion with nuclear energy. We can do it and, when we do it we will be able to find detailed information about distances within our galaxy.

I think we should not conclude this session without giving thought to the long-range exploration and without giving thought to the one very, very, sensational thing that did not happen, that may never happen: find life elsewhere.

DR. GUNN: Now, we're talking about visions throughout the entire Space Symposium this week. If each of you gentlemen in a wrap-up could give me 30 seconds on what thought crosses your mind in terms of vision? Dr. Mark, if you might start.

DR. MARK: Following up on Edward's statement, I'm glad, Edward, that you didn't listen to your mother. You really are a visionary.

DR. TELLER: I am a theorist. I stay at home and think.

DR. MARK: I think this question of life elsewhere is, of course, a supremely important scientific, as well as cultural, question. I think that Edward's mention of the rocks on the south shore of Lake Superior where we found the fossil evidence of blue-green algae in rocks that were three and a half billion years old is very suggestive. One reason for going to Mars, one compelling reason for sending people to Mars, is to look for rocks on Mars that have the same fossil remains of unicellular plants and animals. The fact is

that we know from the Viking results that conditions on Mars three and a half billion years ago were probably quite similar to those on the Earth. There was liquid water; we know that from analyzing the atmosphere. We know that the temperature was roughly the same. So that question is one that I think creates a vision, if you will, for the future of what can and should be done.

DR. GUNN: Thank you. Gen. Kelley?

GEN. KELLEY: This is important work that we do, and we gather together here today to flip around an often used statement. This is rocket science, and we can do it; we are doing it. But I would also be reminded of some guidance I got from an old boss a long time ago, that when we work the biggest problems, you keep touch with the smallest parts. Don't forget about Joe at the Seven-Eleven.

DR. GUNN: Thank you. Dr. Neumann?

DR. NEUMANN: I'm reminded of a panel I was on in 1968. Arthur Clark was the keynote speaker, and he was lamenting how difficult it was getting to write good science fiction. He said, "The future isn't what it used to be." I think there's a wonderful lesson there for us all. We have to keep this wonderful fantasy view of the future, which I think has led us to all sorts of wonderful things. But, we also have to temper it with the reality and understanding the risks, and understanding the balance of all the societal needs. Within that framework I think that there's a great deal of future.

DR. GUNN: Buzz?

DR. ALDRIN: I'd like to stress the value of having an open mind and entertaining the other guy's idea and not trying to knock it. Competition is great; cooperation is great. Somehow we have to learn how to moderate those so that we provide an incentive within an organization to find a great idea outside and not knock it. We all know what NIH means, and that's perhaps one of the greatest impediments to progress.

DR. GUNN: Dr. Teller?

DR. TELLER: I have said everything I wanted to say, except those things which I did not think about and which I will tell you in five years when we meet again.

DR. GUNN: *Excellent, excellent.* Gentlemen thank you so much for joining me today. My guests today have been Apollo astronaut, space pioneer, Chairman of the National Space Society and futurist, Dr. Aldrin; Commander of the Air University of the U.S. Air Force, Lieutenant General Jay Kelley; former Deputy Administrator of NASA and former Secretary of the Air Force, Dr. Hans Mark; long-time moderator of the Internet forum on computer-related risks, Dr. Peter Neumann. And looking forward to seeing you again in five years—and many times in between—and thanking you for coming to the Space Symposium, Director Emeritus of Lawrence Livermore Laboratory, Dr. Edward Teller.

We have to keep this wonderful fantasy view of the future, which I think has led us to all sorts of wonderful things. But, we also have to temper it with the reality and understanding the risks, and understanding the balance of all the societal needs.

I want to give a very special thank you to Dick MacLeod, President of the U.S. Space Foundation, whose vision it was to invite *TechNation* here today. Thank you, Dick. I'd like to thank our audience and our listeners and viewers. I ask all of you, the people here in this room, the generals and the astronauts, the scientists and the engineers, the space executives and the space enthusiasts, and beyond this room to the millions of listeners and viewers on NPR and PBS stations across the United States, to those of you who can hear my voice over 120 countries listening on Armed Forces Radio and Television and digitized audio and video worldwide over the Internet, I want to ask each of you to remember that there is no fantastic reality that was not once a vision. It was never more true that the success of our tomorrow depends on the imagination and the bravery of today. Let each of us ask ourselves: What am I willing to imagine? What am I willing to dare? For *TechNation*, I'm Moira Gunn.

Positioning for the Future

Panel Moderator: **Theresa Foley**
Director, Marketing Supplement
SpaceNews

Keynote: **Steven D. Dorfman**
President, Hughes Telecommunications & Space Company
Senior Vice President, Member Office of the Chairman
Hughes Electronics Corporation

Speakers: **Dr. John Logsdon**
Director, Space Policy Institute
George Washington University

Gen. Bernard A. Schriever, USAF (Ret.)
First Commander
U.S. Air Force Systems Command

Thomas F. Rogers
President
Space Transportation Association

MR. PAYNE: Now that we've gained some insight into the visions of the future, by an outstanding panel, we will discuss how we best position ourselves for that future. It's now my pleasure to introduce Theresa Foley, the director of Marketing Supplements for *SpaceNews*. Theresa Foley is a freelance writer specializing in space programs and issues. She's been doing that for the past 15 years, which included five years as editor of *SpaceNews* and three years as space technology editor of *Aviation Week* and *Space Technology*. She's written hundreds of excellent articles, covering an entire range of space endeavors from launchers, communications and small satellites to U.S. military, NASA, and international programs. Please welcome our moderator for our next session, Positioning for the Future, Ms. Theresa Foley.

MS. FOLEY: Good morning, and welcome to the panel on Positioning for the Future. Moira Gunn's panel gave us some exciting places to go: Mars, the moon, space tourism. The question we are going to look at now is how do we get headed in that direction, or whatever direction Joe-Bag-of-Doughnuts wants us to go in. Times have changed. I can remember a few years ago we used to call him Joe-Six-Pack, but apparently that's now politically incorrect, so he's having doughnuts and sugar instead of beer.

Our keynote speaker this morning is Steve Dorfman, senior vice president of Hughes Electronics Corp. and president of Hughes Aircraft Company's telecommunications and space sector. Steve has long been one of the most influential voices in the space business community. He has led Hughes to the enviable position of dominant supplier of satellites in the world today. He is not a man to shy away from controversy and is unquestionably among the small group of experts on the subject of how to make money in space without relying 100 percent on the U.S. government as your customer. In fact, his point of view on the future of space may be particularly appropriate to kick off this panel, since even if the government got out of the space business tomorrow, Steve Dorfman would still have a job; a claim that not everybody in this business can make. He's been with Hughes since 1957, ascending the company ladder through a series of positions that combine management and engineering on programs that included LandSat, Pioneer Venus, and a list of telecommunication satellite projects that would take the entire 20 minutes he's allotted to speak even to name. So with that I would like to turn the podium over to Steve Dorfman.

MR. DORFMAN: Thank you, Theresa, for that very nice and very kind introduction. I think that the United States Space Foundation does a terrific job of organizing this conference, and it's clear to me that the key lies with all of these young volunteers from the local Air Force and space community. Yesterday, as I was out in the lobby, I noted a young lieutenant from Falcon who was mastering the use of the shredding machine that they have out there. A three star general came up to the lieutenant and, noticing that he was working this machine, said, "Son, can you help me with this document?" The young lieutenant said "yes, sir" and snapped to attention, took the document, got the shredder working, and put the document into the shredder. As it was disappearing into the machine, the general said, "I'll only be needing one copy, son." I think the message for the generals and for the space executives, for all of us, is to have an understanding of the new technologies that we're talking about, what they can do, and how to master them.

I've been asked to talk about the future of the space program, and for me that's especially appropriate. As Theresa indicated, I graduated the year the U.S. space program began officially, after the launch of the Russian Sputnik. So, the space program and my career are both the same age, 38 years old. The excitement of those early years motivated me to pursue a career in the space program, as I'm sure it did as well for many of you in this room. So, essentially all of my adult life has been shaped by the space program, and I have not been disappointed. Quite the contrary. It's been a thrill to be a part of it, all of it. Even today, especially today, I perceive unprecedented opportunities, especially in those areas of greatest personal interest to me—namely, space exploration,

both manned and unmanned; national security; and navigation and commercial applications of space and communications.

In fact, to tell you the truth, I wish my career were starting today, because of all the exciting opportunities ahead. But just as there are unprecedented opportunities, there are also unprecedented challenges. One of these, of course, is the fall-off in government funding of the space program, with tighter budgets across the board. In this context, "better, faster, cheaper," in the words of Dan Goldin, has become essential not only for NASA, not only for DoD, not only for the space program, but for government in general. I think Vice President Gore's concept of reinventing the government is right on, and it's something we all have to do in the space program and in industry.

So, the challenge that this new "better, faster, cheaper" imperative imposes on companies like Hughes is considerable. In order to continue to serve our commercial and government customers in this new environment, we have to learn to do more for less. I believe that's feasible; we *can* do more for less with improvements in productivity and technology.

During the next few minutes, I would like to offer a few observations about the future of the space program. In using the term "space program," I include not only NASA and DoD, but also the satellite-based commercial applications of space, particularly communications and navigation. But first I would like to talk about space exploration. In my view manned space will continue to be the largest single component of the space program—constituting approximately a quarter of the total U.S. space program and half of NASA's. The shuttle continues to demonstrate its credentials as a spectacular machine, with six to eight successful launches per year, and I think that's going to continue on into the next century.

Who is not overwhelmed with the grandeur and the audacity of the space program when they go into the vertical assembly building to see the shuttle being assembled? Or when they watch a shuttle launch from Florida? And I hope that sense of awe continues for me well into the future. I happen to be personally indebted to the shuttle team and to the astronauts who, to date, have rescued four Hughes satellites over the years that were in the wrong orbit and had to be placed in the right orbit. I think Tom Wolfe was right on when he credited the astronauts with having "the right stuff." I've never met a better or braver group, and last night I bought Jim Lovell's book, which I'm looking forward to reading.

Dan Goldin has done a brilliant job, in my estimation, of securing a future for the space station by making it a multinational venture. And what better way to symbolize the end of the Cold War than with such strong Russian participation? It seems like only yesterday that Jim Beggs was selling the space station program as a way of competing with the Russians, and now we're collaborating with the Russians.

Of course, this collaboration adds fantastic technical and management challenges to the program, which, in turn, underscore another challenge that we face; namely, safety. It reminds us that we should never again mislead our nation to believe that space travel is safe. No matter how much we emphasize safety, there is a possibility that there will be more accidents and perhaps more lives lost, and we should be prepared for that possibility.

As we consider both our manned and unmanned programs over the next decade, "better, faster, cheaper" is an excellent motto for NASA, which must renew itself as all mature organizations must. Dan Goldin's announced plan to downsize people rather than programs is excellent, and consistent with the restructuring occurring throughout the world. For example, in my company, Hughes, we have reduced our work force more than 30 percent since 1988, even though our sales were growing during the same time period. A major restructuring at NASA will be challenging in a civil service environment. But where there's a will, there's a way. It must be done.

As we consider both our manned and unmanned programs over the next decade, "better, faster, cheaper" is an excellent motto for NASA, which must renew itself as all mature organizations must.

NASA distinguished itself as a superior management team already in the '60s. The Apollo program exemplified excellence in the management of launch programs. Now, NASA has an opportunity to lead the way in reinventing government organizations according to the model advocated by Al Gore. I think there's a NASA leadership role here that could be very impressive.

As NASA reinvents itself, restructuring will also include diversification. An efficient, less bureaucratic operation will free up resources that can be used to expand the number and range of NASA programs. I believe that NASA's planetary program will be a major beneficiary of the agency's restructuring, and that a better mix of programs can be carried out. This includes large programs, like Galileo, but also small programs, as discussed in the previous session about smaller spacecraft. I'm particularly impressed with the Discovery program and the opportunity it presents for more frequent launches. We have to get out of the situation we've gotten ourselves into, which is a planetary launch every five to 10 years, where we put all our eggs in one basket and then suffer the bitter disappointment such as we experienced with the Mars Observer failure. The Discovery program offers the

opportunity of a launch every year, instead of every decade, and I think that's a course of action we should be pursuing.

While a restructuring will help NASA achieve these goals of expanding its breadth as well as its depth, technology will also play a clear role. Advances in space technology will enable NASA to perform future space missions at lower costs. A good example can be found in the recent TDRS acquisition. The next generation of TDRS spacecraft—that's Tracking and Data Relay Satellites—will use new technology and will cost one half of what the first generation of TDRS satellites cost per satellite. Furthermore the new TDRS will be able to be launched on an Atlas 2-class vehicle, instead of Shuttle/IUS, for a quarter of the cost. I think that's an example of what can be done with the new technology. The TDRS acquisition also benefited from changes in the procurement process, and these changes will produce additional cost savings for NASA. For this procurement, NASA adopted commercial practices by identifying requirements and allowing the contractor, in this case Hughes, to determine how best to meet those requirements.

The ubiquitous reach of our all-learning, all-seeing satellites makes them indispensable parts of our national security program.

As NASA's space program matures, it will also benefit from new management approaches. For example, partnerships between academia, industry, and government can be very powerful, and the Discovery program, as an example, encourages this. In our case, we're teamed with Richard Goody of Harvard as the principal investigator and JPL on a proposal for a multi-probe mission to Venus, which will be a follow-up to the successful Pioneer Venus mission. We are competing against other teams for this total science mission, and the final determination of which mission goes will be based upon peer reviews of the value of the science mission and its cost. Science is maximized, bureaucracy is minimized, and I think that's a good example of the many profound changes underway at NASA.

If manned and unmanned explorations and scientific missions are the most exciting components of the space program, then space-based national security missions are surely the most underappreciated. Classification requirements have prevented the public from fully understanding how important the space program has been to national security. Our eyes and ears in space were a major factor in our Cold War victory, and they demonstrated their decisive power on the battlefield in the Gulf War. Our defense satellites helped us win the Iraqi war in ten hours. The unprecedented situational awareness these satellites gave our men and women brought them home with minimum bloodshed.

But the Gulf War also showed us that the world is still a dangerous place, and that threats can come from anywhere. The ubiquitous reach of our all-learning, all-seeing satellites makes them indispensable parts of our national security program. Reconnaissance, communications, and dissemination of information to end users will be of increasing importance. And here again, technology improvements will make these satellites more cost effective parts of our national security program. The term "more for less" is equally appropriate here. Many satellites will be downsized from shuttle- or Titan 4-class launch vehicles to Atlas- or Delta-class launch vehicles, creating substantial reductions in the cost of manufacturing and launching those satellites. Again, more for less.

In addition to the positive changes brought about by technology improvements, additional benefits are resulting from changes to the acquisition system. As an example, the Navy UHF Follow-on program, which Hughes is under contract to carry out, used a commercial acquisition approach that enabled Hughes to base our winning bid on our dual-use HS601 bus. In this way, the Navy was able to purchase 10 satellites at an average fixed price of $170 million per satellite, including the cost of launching those satellites. This was an unprecedented price compared to previous programs, and even more remarkable considering the fact that it had a complicated SHF, UHF and EHF communications payload. The acquisition approach used by NASA for TDRS and by the Navy for the UHF Follow-on program enabled us to maximize dual use. The HS601 bus now serves as the key element for 13 government satellites and more than 18 commercial satellites. Both our commercial and our government customers benefit as a consequence. I expect to see more of this in the upcoming SBIR and GPS acquisitions. I expect DoD to utilize these same kinds of acquisition approaches to get more affordable programs. Again, more for less.

What we have achieved and will continue to achieve in our manned and unmanned space programs and in our national security space program is truly breathtaking. Now, however, I would like to turn to two other areas in our space program that offer even greater opportunities, in terms of creating jobs and boosting this nation's economy. I believe the two applications of navigation and communication will continue to offer us our most significant opportunities for commercial accomplishments.

As the Air Force prepares to acquire the third generation of GPS spacecraft, GPS continues to grow in its worldwide use. Hans Mark talked about how he, at the University of Texas, is going into business using GPS. I think there's going to be a lot more of that, because the cost of GPS chip sets is going down dramatically, and as that happens the use of GPS

receivers will become more prevalent in cars and portable phones, even in backpacker gear. Also, the GPS satellites will become a core element of worldwide air traffic control systems and will be used for fuel-efficient aircraft navigation, approaches, and, ultimately, landing. So, I think we're going to find that third-world countries using GPS will have more modern and more efficient air traffic control systems than many modern countries, including our own.

Similarly, new applications are proliferating for commercial communications, which is the focus of my business. As a result, this business is achieving unprecedented growth. There are already 145 geostationary commercial communication satellites in orbit today. Like other manufacturers, Hughes is experiencing record backlogs as we did last year, this year, and next year. We will be launching an average of about one satellite per month. In fact, we have one scheduled to launch this afternoon, so I want all you guys to be rooting for us. I believe that industry will be launching an average of 25 to 30 satellites a year for the next decade and perhaps into the next century. There even may be more, if some of the more ambitious plans are realized. There are 900 filings for new communication satellites before the International Telecommunications Union. I don't think all of these will go, but many may. And those 900 do not include all the low Earth orbit satellites that have been proposed by Iridium, Globalstar, and Teledesic.

One of the greatest challenges lying ahead of us is launching all those satellites, and I'm going to talk about that in a few minutes. But first I want to talk a little bit more about what's causing this explosion in satellite communication, because it's the fundamental theme that I'm addressing today, and that is technological advances. As they infuse the commercial satellites with more capabilities to do more for less, they lower end-user costs and they stimulate demand, both in the commercial sector and ultimately in the government sector. Today's satellites are more powerful and efficient. Digital components and signal processing improvements are the most spectacular factors for these breakthroughs, but there are others. Reconfigurable spot beam antennas shape the beams more accurately and weigh less. Miniaturization and component improvements have made on-board receivers more sensitive and lighter. Traveling wave tubes and solid state power amplifiers are more efficient—and are getting even more efficient—and hence require less prime power, reducing the cost and size of the power supply. Batteries and solar panels are more efficient and lighter. Microprocessors simplify tracking, telemetry, and command. Modern composite techniques make for more efficient structures, and on-board propulsion has become more cost efficient.

At the same time, on the ground, Earth terminals have become smaller and more efficient, and are costing less because of improvements in receiver sensitivity antenna efficiency, and the use of signal processing. Digital communication and compression is dramatically increasing satellite capacity.

In keeping with our goals of providing our customers more for less, we at Hughes, and other companies also, are incorporating these technology improvements into our satellites and systems. As an example, we developed a lightweight xenon ion propulsion system that was originally sponsored by NASA for station keeping and that replaces a heavier chemical version. By using this, we can save 800 pounds of propulsion, and that reduces the launch cost for our customers by $10 million. We'll be launching the first satellite using this propulsion system at the end of this year, Galaxy 3-R.

There are 900 filings for new communication satellites before the International Telecommunications Union. I don't think all of these will go, but many may.

These technologies, combined with productivity improvements, which I'll mention later, have improved the cost effectiveness of Hughes' communication satellites by a factor of 25 in the last 10 years. That cost-effectiveness factor incorporates such measures as improved power, lifetime data compression, and costs. As a result, the technological advances, the more powerful satellites, and the cost savings I've been talking about have stimulated new commercial satellite applications. Communications is a very elastic marketplace. I'm talking about communications in general; so, the lower the cost, the more utilization, and the increase in utilization ultimately leads to increased sales. In our case, three of the most promising new commercial satellite applications are direct-to-home television, mobile telephony, and high-speed interactive voice, data, and video transmission.

First I'm going to talk about direct-to-home television. At the 1977 World Administrative Radio Conference 18 years ago, it was assumed that 60dBW, the equivalent of a million watts, would be required for direct-to-home transmission and it would require one-meter receive dishes. Well, today, with all the technology improvements I've talked about, you can do direct-to-home television using a half-meter dish and only 50dBW, or 100,000 watts. What this has led to in a very practical sense is the very successful DirecTV satellite. I hope many of you already have your DirecTV systems, and if you haven't, you should go out and buy one! We put DirecTV into service last year with the launch of our first two satellites, DBS-1 and DBS-2, and we're going to launch a third DBS satellite later this year. As many of you know, by incorporating all the technology advances I've mentioned and by using an uplink center located a half hour from this facility, we're able to provide more

than 150 channels of very high quality digital video. And after something like six months of being in service, we can't keep up with the demand for the receivers, which are being built by RCA and now Sony.

We have 400,000 viewers; we expect that number will be a million and a half by the end of this year and over three million next year. This is not happening only in the United States. It's happening worldwide, and next year we will begin business in Latin America with a very similar system. We're calling it DirecTV Latin America, and again we'll be using high power satellites to transmit to small dishes. Programs will be in Spanish and Portuguese. Direct-to-home TV is a worldwide phenomenon that is growing rapidly. I estimate that today there are 25 million people with privately owned dishes who are watching television via satellites built by Hughes and others. They're watching American programming like ESPN and CNN and Home Box Office, as well as local and regional programming.

Ensuring access to a sufficient and competitively priced supply of launch vehicles is critical to our business into space.

Another area of commercial opportunity is satellite mobile telephony. Inmarsat has pioneered this and serves tens of thousands of maritime and aeronautical customers. This afternoon, Hughes will launch the first of a next generation of satellites that will provide ubiquitous communications for phone users in cars, boats, trucks, and trains throughout North America. This satellite, which is owned by American Mobile Satellite Corporation, will also enable interactive data transmission and will be linked to the GPS system.

I'm expecting mobile telephones to be a very important application in the United States, but I believe the demand will be even greater outside the United States. Along with many other companies, such as Motorola, Loral, Qualcomm, and TRW, Hughes is working on the next generation of mobile satellites, which will permit the use of handheld phones. Early this year we signed a contract with a company in India to provide hand-held mobile telephone service—16,000 circuits using geostationary communication satellites. Our satellite will have an unfurlable 40-foot antenna, will use on-board processing and spot beams, and all the technologies I mentioned earlier. We're expecting to sell a lot more of those satellites, and I think that by the end of the decade, ubiquitous, global handheld telephony and other services of that kind will be available.

Now the final commercial application that I see exploding is interactive, high data rate voice and video services, perhaps using Ka band, which was pioneered by NASA. Bill Gates and Craig McCaw made headlines with their proposed Teledesic system, a very bold vision comprising 940 satellites. We have proposed a more modest system in geostationary orbit: nine satellites at Ka band. These satellites will enable videoconferencing to be done internationally at prices that are lower than the cost of an international telephone call today. It will also enable us to make an international telephone call for less than the cost of today's domestic telephone calls. That's less than ten cents a minute. We're calling this satellite system Spaceway, and it's an integral part of our vision for the future. Spaceway, the mobile telephony satellites, and the DBS video satellites all will be part of the global information infrastructure that Al Gore and this Administration are keen proponents of. By taking this leadership, America will design and build the telecommunications networks that will serve the world in the 21st century.

Now, all that I've talked about depends upon reliable, affordable access to space—launch vehicles—and that's the part of the space program I'm personally most concerned about. While in the last 10 years the cost effectiveness of communication satellites has improved by a factor of 25, the cost of getting into space has been flat, when measured in terms of dollars per pound. In fact, in some cases it has been going up. That's going to affect our communications business. We've reached the point where launch and insurance costs now exceed the cost of the satellite itself, when we figure the total cost of putting a satellite into orbit. And there are still entirely too many launch failures, which also impacts cost because it drives up insurance rates. In addition to these issues of cost and reliability, I also am concerned about whether there will be an adequate supply of launch vehicles to ensure that my satellite vision can become reality. We must consider how we will launch not just the communication satellites, but all satellites, including the government spacecraft, and the additional spacecraft that are going to be launched because of the changes at DoD and NASA.

Ensuring access to a sufficient and competitively priced supply of launch vehicles is critical to our business into space. In the short term, we must have access to foreign launch vehicles. Two-thirds of Hughes' satellites—in fact, two-thirds of all communication satellites—are now being launched by foreign launch vehicles, and I think that for the immediate future continuing to have that option is going to be a necessity. But, in the longer term, I believe we need more cost-effective launch vehicles that serve the U.S. government and commercial industry. An upgraded and strengthened U.S. launch vehicle industry would serve two key purposes. First, it would better support the U.S. space program, especially given the larger number of spacecraft we will need to launch. And second, it would bolster America's ability to compete

in the international launch vehicle marketplace. As we know, this problem has been talked about for a long time, and in times of austerity it's been tough to get such a program funded. But I submit that, with a $30 billion plus per year space program, a rather small investment in space launch capability would seem to be a prudent investment. NASA's planned development of reusable launch vehicle technology offers NASA the unique opportunity to exercise a leadership role. A new cost-effective RLV could make a heck of a difference in the future, so I support that investment.

Assuming we overcome this problem of launch capability, I'm very optimistic about the future of the U.S. space program. I think that success will come to us as long as we understand that we must meet the demands of our customers. In the case of the government program, those customers are the U.S. taxpayers. They, like our commercial customers, expect and deserve the best performance and the best quality at the lowest cost. To fulfill this requirement, we in industry and in government need to continue to strive to do more for less. Meeting the "better, faster, cheaper" imperative will ensure a vigorous program into the next millennium. Thank you very much.

MS. FOLEY: His speech gave me a lot to think about, I don't know about you all. One comment that Steve made about the military satellites not getting their due reminded me that I was in the Golden Bee last night with a group from Washington, eating doughnuts, of course, and someone told me that there's going to be a coming out party for the NRO in the next couple of weeks in Washington. There's going to be a lot of the history of that that the press has never been privy to and most I think of people who don't have the right clearances are going to get access to that. So, I look forward to hearing, and maybe next year we can have a session and hear about what those satellites have done over the years.

We're now going to turn to the rest of the panel who have to follow Steve Dorfman, but try to be just as illuminating. We have a faster, cheaper, better panel here, but half the number of minutes. Their task is doubly hard because we've asked them to speak about what often seems to be an impenetrable subject, that is the future of the space program. All that can be said for sure is that there will be a space program. What it's going to look like in five or 10 years usually seems pretty mysterious, even to those of us who spend most of our waking hours thinking about space. We know there will be a space station, we even know what it looks like, at least for the last year. We know we have a space shuttle, but how long before it stops flying, whether by design or accident, no none can say. We know there will be a growing fleet of profit making commercial satellites of an ever-increasing size and changing shape; that's a certainty. Military satellites without a doubt, but for strategic defense or other purposes, who knows?

The bad news is there this year as well, and one can predict doom and gloom for space if one chooses to. NASA's shriveling budget is going to take the agency down a few more notches. White House policy is apathetic at best. Public opinion seems to be at a low point, if some of the recent surveys are to be believed. And the top Pentagon officials accept military space as a necessity, but we no longer have the luxury of avid support for new technology, satellites and weapons as we did 10 years ago. The industry is consolidating at a frightening pace, and NASA is to the point where lately it has had on more than one occasion received only one credible bid for a contract—not a good situation. Nobody talks about it, but radio-isotope-thermal generators look to be on their last legs; without some kind of nuclear power supply for space, one sure prediction for the future is that we won't be going far from home.

The real renaissance for the space program will come through the commercial and military businesses, and we're likely to see the upturn in those two sectors first, within five years or so.

If you want to take your sense of hopelessness to an even greater height, pick up a copy of last week's lawsuit filed by satellite owner AT&T against its supplier, the biggest space company on the planet. The content of the filing is disturbing, allegations of fraud and deceit worthy of a Tom Clancy novel. While AT&T's charges remain to be proven, these are the kinds of accusations, failures, and troubles that leave the public with a very bad taste in its mouth, as far as space goes.

It's very hard to get excited about the future when the present looks so bleak. But, before you get too depressed, I wanted to call to mind something that happens to everybody, something that I call the law of rotation. If you think about it you can see the law of rotation applies to our individual lives, just as much as the law guides the spinning of the planets and atomic particles. So, if you're feeling a bit hopeless, remember that this is a cyclical business and we are really in a low point. How long will it last? Can you ride it out and survive?

As a journalist, I've been trying to get the answer to that question for the last two to three years, and if I could figure out when the space drought will end, my publishing clients would pay me a small fortune for the story. Unfortunately, my guess is as good as anybody else's, a risk venturing it here. The drought for NASA's going to be a long one, lasting well into the next century, largely due to the obsession the agency

has with the shuttle and the space station. The real renaissance for the space program will come through the commercial and military businesses, and we're likely to see the upturn in those two sectors first, within five years or so. Commercial is already there, though people usually take it for granted.

Enough from me. You came here to hear the panelists, and we have three more who are going to speak before the coffee break. The format will be much different from the first panel. The rules are each of the next three speakers will have 10 minutes. I'm allowed to use all of the means at the disposal of the fourth estate to pressure them to stay on time. That includes interviewing them, not interviewing them, writing a story about them, and not writing a story about them. So I guess I'll either be writing a very big one about Hughes tomorrow, or not. When the final panelist is finished, all four members will rejoin us up on the stage and we'll take questions from the audience. So if you have a question, please write it down and someone will collect it.

Our first panelist is John Logsdon. He's director of The Center for International Science and Technology Policy and the Space Policy Institute of George Washington University's Elliot School of International Affairs. John is a professor of political science and international affairs and has taught at GW since 1970. He serves on many advisory boards and consults with several organizations. Many of you may be familiar with him through the news media, since he's probably the panelist who would win the prize for being quoted the most in the press on the subject of space policy; that is, as long as John Pike isn't here this year, and I don't think he is. With that I turn the audience over to John Logsdon.

MR. LOGSDON: When I thought about what I might add to this morning's distinguished panel, I rather quickly came to the conclusion that I should take its title, "Positioning for the Future," quite literally. Thus the question I want to pose and discuss is: "What position in space should the United States seek as it develops a national space policy for the 21st century?"

As far as I know, the last comprehensive statement of national space policy was issued on November 2, 1989; it itself was largely a reiteration of the final policy statement of the Reagan administration. That statement declared that "A fundamental objective guiding United States space activities has been, and continues to be, space leadership."

Is this objective still valid today, given all that has changed in the world and in this country since 1989? Should the United States still seek the leadership position as its fundamental objective in space? If not, what ought to replace the quest for leadership as the guiding principle of U.S. space policy?

To answer these questions requires a comprehensive assessment of what the United States wants out of its civilian, national security and commercial space programs. *Leadership* as it has been defined in the past was primarily a political objective. We used space accomplishments to demonstrate to the rest of the world the technological and organizational superiority of the U.S. society—first unilaterally during the Apollo program and then as the managing partner in various cooperative undertakings. We used our order of magnitude larger investments in space to try to influence the space programs of our Allies, not always successfully. We used space as a symbol to ourselves about what was good in American society—our sense of adventure and pushing back frontiers.

Our government space budget, when civilian and national security activities are combined, is still an order of magnitude larger than Europe's. If we can't have a top quality comprehensive space effort for that amount of funding, we have a major problem.

Perhaps we should first ask whether we *could* continue to seek a leadership position, given the shrinking resources we seem willing to allocate to at least the civilian space program. Most of you know about the major reductions in NASA's five-year budget outlook in the past three budget cycles. I suspect almost everyone in this room would like there to be more money available for new space technology and new missions, but we grudgingly might agree that this adjustment in budgets and priority reflects political as well as fiscal reality. Can we have a leadership program at the kind of reduced spending levels that seem to lie ahead?

Sure we can. Consider what the United States government spends on space compared to other space powers. Our government space budget, when civilian and national security activities are combined, is still an order of magnitude larger than Europe's. If we can't have a top quality comprehensive space effort for that amount of funding, we have a major problem. What we need to do is spend the available funds wisely, not sulk in the corner until space budgets are once again on the upswing.

I just commented that we have a major problem if we don't have the leading space program in the world, given the amount of money we spend on space. Arguably, that problem exists—or at least has existed until recently. I interpret Dan Goldin's reforms at NASA and the recent and ongoing changes in the organization of national security space efforts as recognition that there have been major problems in the U.S. approach to space—problems that undermine our quest for comprehensive leadership. We have a program that is broken at the strategic and institutional level,

whatever the accomplishments of its specific programs. We have not been getting the leadership payoffs (and the other benefits sought) that should be expected, given the investment made.

Over the past several years, we have been trying to remedy this situation from the bottom up—by "fixing" specific programs such as station, EOS, or early warning. These case-by-case efforts are certainly necessary, but may not be sufficient. It may well be time to take another top-down look at *all* U.S. activities in space, so that one can size budgets, develop interactions among program elements, make technology investments, and promote international partnerships from a strategic perspective.

Just over two years ago, I participated in the work of a Task Force operating under the auspices of Vice President Quayle's Space Policy Advisory Board, chaired by Laurel Wilkening, that did adopt such a perspective. The group's report, *A Post-Cold War Assessment of U.S. Space Policy*, was issued in December 1992. I believe much of its analysis remains valid, and could form the basis for an inside-the-government national relevance—national security, global stability, new knowledge, advanced technology, commercial prospects, international cooperation—should have priority as we decide what to do in space and how best to implement our choices.

Intelligently positioning ourselves for the future, then, requires the national policy machinery, and also, at least, the attentive public, to take a step or two back from current program controversies and the uncertainty of institutional change. We need to ask ourselves where we want to be in space 10 or 20 years from now. We need to understand where the government must be involved, and how, and where the private sector should take the lead role. We need to create or modify institutions and policies to achieve our objectives. We need to nurture productive and stable international partnerships when those are the preferred way to pursue those objectives.

If we do this, and continue to invest in space at a comparatively much higher level than other countries, we cannot help but be the leading spacefaring country. But rather than declare that position as our objective, we can and should earn it. Thank you.

MS. FOLEY: Thank you, John. You've really set yourself up for the first question with the comment about one more space policy.

Our next speaker is Bernard Schriever, a retired Air Force four star general who has a long list of credentials as a space insider. General Schriever retired from the Air Force in 1966 after serving for 33 years. Since then he has been involved in military space efforts as a consultant, advisor, and corporate board member to several companies. He is an expert on the ABM treaty, serving in the Ballistic Missile Defense Advisory Board and the Defense Science Board. He has been called on repeatedly to serve on government advisory boards, including both the Payne and Stafford commissions that advised previous administrations on future space goals. General Schriever.

GEN. SCHRIEVER: One thing I'm not is an expert on the ABM treaty. I wish it would go away. I've been asked to—well, I don't know whether I've been asked to—but I'm going to speak about military space and the future of military space. I'd like to make a few comments, just very short, on the past. I'm wearing a tie here which has a P-12 on it. Those were the days of the Air Corps back in the early '30s, I doubt very much if many of you have even seen a P-12. I'm sure there's nobody here who's flown one. Now, in the early '30s, air was considered to be a force multiplier. There were people in the Air Corps who were fighting for the recognition of air power, not just a force multiplier. The Gulf War launched space activities and space assets as force multiplier. But in my opinion space is going to go much further, just like air went from the early '30s through World War II. Now we're talking about not just air power and air superiority, but we're also talking about global reaching global power. That certainly is in the future as far as I'm concerned in connection with space.

Now as I said, I'm here (next slide) to talk about the future of military space. To me, future is in the 15-year range, as the current acquisition process takes about that long. Another imponderable, Alfred Mann, the great naval strategist once said, "A peaceful, gain-loving nation is not farsighted, and farsightedness is a need for adequate military preparation." I'm not sure we're in that mode today, but I think we're pretty close to it. The Air Force has a rich space heritage, which culminated shortly after the Gulf War, in General McPeak restating the Air Force mission which specified emphasis of space. He enhanced the Air Force mission to exploit and control air and space. I agree with this completely. I would like to start by quoting from statements made by some leading Air Force commanders in the past. First, Hap Arnold after World War II had great interest in space and asked Von Karman to make a study including the feasibility of a reconnaissance satellite. He also created the Rand Corporation and its first mission was to determine the feasibility of a reconnaissance satellite.

So the Air Force very early on became interested in space and continues to this day. Now LeMay back in 1961, he said, "Looking back at the history of air power, you'll recall the first use of the airplane in war was for reconnaissance. For a time air operations were conducted politely. Opposing pilots waved and nodded at each other as they passed. Both sides had equal access to the sky. But once reconnaissance began changing the course of battles, the rules changed. It didn't take long before commanders realized that it was necessary to deny opposition, to this aid that the sky was providing. Soon opposing airmen were en-

gaged in battle. First it was air-to-air bombs and small arms and then came the machine gun. After this came bombers and the sky had become another arena for active warfare. I think we will be very naive if we don't expect and prepare for the same trend in space." Now this was LeMay's statement in 1961. Horner, 32 years later, after the Gulf War, said, "Using space systems is now fundamental to modern warfare, no one who doesn't understand it is truly not a warrior. He has not studied his art, and therefore denying the enemy access to space is a fundamental to modern warfare." I completely agree with McPeak, LeMay, and Horner with respect to the future of space. Space brings a new infinite arena and another dimension to national security. Control of space could easily become decisive in future conflicts. The space arena will not remain a sanctuary, but is certain to become an arena of conflict. Therefore, it is only prudent to plan accordingly.

We need to rid ourselves of the onus that militarization of space is bad. But rather, by being combat ready, it fills the same role for freedom of space as the navy does for freedom of the seas.

Selling military space power has become a more difficult thing than selling air power back in the 1930s. With this in mind, we must broaden our thinking regarding U.S. policy, that is, the emphasis on space for peaceful purposes. No one can quarrel with this objective, but isn't it true that our long-held policy of freedom of the seas also clearly embraces the seas for peaceful purposes? History indicates that these objectives have on numerous occasions required military action. This being one important reason we have the best navy in the world. Furthermore, this has never led to the charge that our navy militarized the seas; rather, it served as a major deterrence as is looked upon as mandatory to maintain freedom of the seas. We need to rid ourselves of the onus that militarization of space is bad. But rather, by being combat ready, it fills the same role for freedom of space as the navy does for freedom of the seas. In short, the military needs a space force that has more fighting capability beyond just a force multiplier.

It is clear from the Gulf War that any aggressor would consider our space capability a prime target. As we move into the 21st century this will become an increasingly realistic threat. We will need satellite systems that can function in wartime and have a quick response capability to reconstitute, if necessary. Both active and passive defense of our satellites will be required. We must also be able to degrade or destroy enemy satellites. Military wartime exploitation and control cannot be achieved with less. Again, we cannot count on space being a sanctuary, which I think many people wishfully do. It is destined to become a battlefield for the new high ground.

However, our satellite system is designed primarily for peacetime operations which we now have been in. Launch complexes to ground control, to satellites in orbit, down to the war fighter have vulnerable wartime nodes. Unfortunately, in the U.S. there has been no consensus on the need for a wartime fighting capability of our space assets. Our greatest challenge is to change this mindset to an acceptance that our military space force's mission is the control of space in war and freedom of space in peace. We have the technology to get this done.

We need a sense of urgency and the funding. Probably neither will evolve unless a crisis occurs. There is a list of programs that were recommended back in 1988 which dealt with the necessity to provide primarily a rapid space force reconstitution in the event of war. One program leading to this has already been mentioned—a completely reusable space lifter. We need to continue studies such as Space Cast 2020 and the current SAB study on the anniversary of Von Karman's *Toward New Horizons* study back in 1945.

I see my time is up; there is no point in discussing in detail the programs. They're all known. They're all in the books. But space programs need a further sense of urgency to get the kind of support that they need to provide a war fighting capability in space. And I say this, in the 21st century there will be the threats that will require them. Thank you.

MS. FOLEY: Our last panelist is Tom Rogers, President of the Space Transportation Association. He is a physicist, engineer and private investor. Tom began his career doing scientific and technical work on atmospheric phenomena, moving on to focus on communications, rockets, and nuclear missiles. His career evolved from helping to get satellite and laser research efforts started in the Defense Department to working at HUD and helping to found the Urban Institute. His biography is quite lengthy, and I'll summarize by saying that he has been a futurist and explorer for decades, and I'm sure we'd rather use the remaining time to hear what he has to say about the future of space than to listen to me read you more details of his many achievements and accolades. Tom.

MR. ROGERS: I'd prefer to stand here with you this morning wearing the title of chairman of The Sophron Foundation. I really enjoy my job at the Space Transportation Association, but after what I have to say today, I'd just as soon you addressed your letters to my Foundation than to the Association.

The title of my talk is the Future Federal Civil Space Program, Page Zero, Page One and Page Two Issues.

Dan Goldin is reported in the current issue of the

Air and Space Museum magazine as follows. He makes a point to ask as many people as he can what they want from a space program. Not surprisingly, the answer is only sometimes a space station. So he talks of pushing outward to the next destination. He says only three missions are feasible: a return to the moon, a research station on an asteroid, or a trip to Mars. We should work on the space station so one of these three things can happen. In my view, unfortunately, these are what I would describe as "page two" aspirations. They assume that a decade hence there will be a sufficiently large national capacity and will to see them pursued. They are "page two."

What is the zero page issue? Well, the age of miracles has not yet ceased. Let me read to you from page seven of the NASA Strategic Plan out in February of this year. "Recent public opinion polls continue to show support for U.S. endeavors in space. However, in polls which prioritize national programs, space often does not fair as well as it has in recent years. Continued public support will depend on our ability to satisfy the nation's needs."

Let me repeat that. "Continued public support will depend on our ability to satisfy the nation's needs." That is the zero order issue. That is what should have been on page one in the NASA Strategic Plan. And everything else in it should have flowed from it. And what Dan is talking about should flow from it. They don't.

I am afraid that if the trend in the civil space area is downward, I don't have to add anything to what John has said and Theresa has said this morning. I just would point out to you that if, adjusting for inflation, the NASA budget goes down at between 5 and 10 percent per year, a decade from now at 5 percent they'd have eight billion per year; 10 years, they'd have five billion per year. The space station and shuttle cost about five billion. Even I can do that arithmetic.

Well, what is the first of the page one issues? The administration, thank God, is attacking one of its two fundamental problems. I have been spending the last three years of my life doing what I can to help drive down the unit cost of basic space transportation. Make it more safe, make it more reliable; drive down the cost per pound and per passenger. Without that, ladies and gentlemen, we are dead. And not by a factor of two or a factor of three. By orders of magnitude. The water is in there; it must, and it can, be squeezed out. If it isn't, we're dead.

And by the way, we'll hear from Jack Mansfield later on here. He and others, especially Dan Goldin, deserve one hell of a lot credit for that. And Jack and the others, they're off and running. So far so good.

Now what is the second issue? Cheaper, better, faster what? Cheaper, better, faster what? Let me translate the statement in the space strategic plan of NASA: whenever the value of public spending upon civil space is compared to spending upon improving the criminal justice system, to improving education, to improving the delivery of health services, you name it, space comes last. Sometimes, it's not even on the chart. By and large, the administration's civil space aspirations today would do nothing to increase the program's sharply diminished general public constituent support.

By and large, the administration's civil space aspirations today would do nothing to increase the program's sharply diminished general public constituent support.

That's the remaining zero order issue today. We have two of them. One is being worked on very hard; the other is ignored. At least we're *not* suffering from don't-know-squared anymore. We are saying we do know that we are *not* doing what the American public would like to see done and to support.

Well, contrast for instance what Dan had to say about the space station and what Bob Walker had to say to the Space Transportation Association a few months ago—his view of the space station. His view is that the space station should be a publicly funded centerpiece of a private sector space business park supported by privately created and operated low-cost space transportation systems. He's not talking about going to the planets.

For now I will give you what I believe should be the goal—the major goal—of our Federal, civil and power programs. I don't care what else we do, providing this goal is addressed, hard: we must see low earth orbit opened up to the general public and free enterprise. I don't care what else we do. That we must do. And we must do it in a business-like fashion. We've got to get on with getting our people up there as tourists and as business people.

One other comment. Whatever else one can say about space today, you certainly must say it has turned out to be quite dull. Can any of you really stand up and say what's going on up there in the shuttle? Who are the individuals up there?

So let's get some fun into it. Let's get some excitement. Let's get some competition. Let's get some sports going on in space. I have my own judgment as to which sports I would like to see go on. I'd like to see men and women "jumping" down from orbit. The first one that lands on the ground, alive, gets into the Guinness Book of Records. And the second one is: who gets closest to the X on the ground in downtown Waverly, Kansas, establishes the next record. And so on and so on. Let's get some excitement. Let's get some verve. Let's get some competition. Let's start it with the young men and women of our Air Force Academy and our Naval Academy. Later, let's challenge the Russians. That will have people watching

what's going on in space!

Another thing that should be going on in orbit, a much more sober one, is relevant to Medicare and Medicaid and the great cost of those programs and what they're doing to discretionary spending and what they're doing to the Federal deficit.

We must start in the space area to generate wealth, not just spend it.

We know that, in the absence of the local force of gravity in low Earth orbit, you can study the aging process. And I believe that we have Nobel Prizes in the offing in such life sciences study in low Earth orbit. (You know, there hasn't been a Nobel Prize, to my knowledge, awarded in the space area. Fifty years, a half-trillion dollars, and not a single Nobel Prize.) I would suggest focusing on aging related life sciences, to learn about what happens to people as they get old. We see what happens to the astronauts in orbit. (They recover quickly upon return to the surface.) We can imagine research for results being obtained up there much faster—by orders of magnitude.

Now, just so my point isn't missed, I want to say one thing just a little bit differently. We must get our general public into low Earth orbit. In polls in the 1980s, 80 million adults of the United States said they wanted to take a trip to space. Eighty million! What a potential constituency! Administration after administration that has led the greatest democracy in the world has taken the position that we will not let our general public go to space. That is outrageous! It is also pretty damned dumb.

So, in signing off, I would say that what we must be doing over the next few years is focusing on the general public getting to space—free enterprise getting to space. We must start in the space area to generate wealth, not just spend it. We must think big about space. Large numbers of small things. Get the unit cost down. And we must develop large—and I take my hat off to Steve Dorfman—large additional private sector business markets.

Thank you very much for having me out here.

Q&A

MS. FOLEY: A comment was made to me was that NASA has a constituency of one, and that is the President, and what the President wants the space program to do is basically what gets done. There have only been two Presidents in the history of the space program who have cared a hoot about space and those would be Reagan and Kennedy. So I wanted to ask anyone on the panel who would like to comment on that, whether that's a valid viewpoint and, if so, does that mean we all have to begin obsessing about the presidential election, and should we all be hoping that Clinton gets washed away because he hasn't done anything for us except cut the budget?

MR. ROGERS: I think it's a perfectly reasonable, tactical thing to say. And a perfectly dumb thing to say strategically.

GENERAL SCHRIEVER: Really?

MR. ROGERS: Remember: of the people, by the people, for the people. The President is in the job as long as we allow him to have it. *NASA's main customer is the general public.* And when it appreciates that, it's 90 percent of the way there. The President will do what he believes the public wants to have done; that's his job.

Remember: of the people, by the people, for the people. The President is in the job as long as we allow him to have it. *NASA's main customer is the general public.* And when it appreciates that, it's 90 percent of the way there. The President will do what he believes the public wants to have done; that's his job.

MS. FOLEY: John, would you like to add to that?

DR. LOGSDON: I think it goes back to the point I was trying to make. As long as the program is driven by considerations of politically defined leadership, then Presidential engagement is crucially important. But if the era is behind us, in which such leadership should be the driver of the program, then I think it's both President and the Congress as reflecting the public will that ought to be defining the future in space.

MS. FOLEY: Anybody want to say anything about the elections that are, what, now two years off?

DR. LOGSDON: They're going to happen.

MR. DORFMAN: I'd like to say a few things about that. First of all, I think the public is very supportive of the space program and the NASA space program, whose budget has increased during periods when most other agencies have seen their budgets go down. Second, I believe $14 billion is one hell of a lot of money, and I think you can do a lot with those $14 billion. And so I think that's the challenge that NASA has, and I think that NASA management is stepping up to that challenge and trying to be more effective.

That was the point of my presentation. I think it's do-able. I think you can have a very strong explora-

tion program, which is good science. I think you can have a strong Earth observation program. And you can have a man-in-space program. I think the issue with the man in space program is that it's not a necessity; it's a luxury. I know that people might quibble with that, but I think, in fact, that's the perception that most taxpayers have. And the difficulty we all are challenged with is the decision of whether or not to proceed with it, because it's perceived as a luxury by the taxpayers. Fortunately for the space station, it was tested several times and it's come through.

The challenge we have now is to make it an international program. That means it will have to survive scrutiny in every single country, and each has the same exact fiscal environment we have. So it's going to be a challenge to keep the space station going. But it's a management challenge, which, I think, if we focus on it, we could be very successful in overcoming.

So I think $14 billion a year is good enough for a space program, and that we have the support of the people. It's now just a question of us coming through for them.

I think the issue with the man in space program is that it's not a necessity; it's a luxury.

MR. ROGERS: I don't know whether I agree or disagree with Steve on one thing, but we may have a semantic problem here. Certainly the American people *are* interested in space. They love it. But we forget the conical male story. You know, the story of two men who went through college together. They corresponded, they didn't see each other. They met suddenly 10 years later. They were talking. One asked "How's your wife?" The other replied, "Hmm?" The first repeated, "Well, how's your wife?" The other responded, "Well, I don't understand." Dumfounded, the first one asked,"You don't understand? What? How's your wife?" The second responded, "Compared to what?"

I'm talking about constituencies, not general interest. I'm talking about people who will go to the wall for your program and fight the other people who want to get the money that you've got and the authority that you've got and the regulations that you've got. So, we may have semantics here, but I'm talking about constituencies, not general interest.

The second thing about people going to space. We don't run the world the way we did. The Japanese are giving this matter a great deal of thought, a great deal of thought. They're laying their plans, they're conducting market surveys, they've got the first conceptual design of the first tourist-carrying spaceship. So when I think of a manned space program, I think of the general public going up there, not technicians like myself.

MS. FOLEY: I want to move on to some of the questions from the audience, but Tom, I also wanted to comment that I think you've hit on one of the main problems that's bogging the space program down that people don't usually acknowledge. And that is the fighting among people for money and power. That often takes place of a vision or an end goal that is a higher noble purpose. Last night, watching the Apollo 13 video, it was wonderful to see the motivation that was there, and I don't know that we have that similar drive behind a lot of the things that are done in Washington today.

We could go on on that subject for a long time. I've got about 30 questions and I'm sorry we'll only be able to do a couple of them. For Steve Dorfman, how long do you think it will take NASA to transform itself into an efficient management organization? IBM said they were going to take seven years and maybe or maybe not they're there now. What about NASA? Will it be faster or longer?

MR. DORFMAN: I think there's no way of saying when they will achieve the goal of becoming an efficient organization. I think, like all organizations, they have to be constantly improving, and I think they are improving. They've set an objective recently to downsize by 10 to 15 percent over the next few years. I think it's just a continuing process and I think they are now focused on that, like all institutions. I'm hopeful they're going to succeed.

MS. FOLEY: And a question for Dr. Logsdon, and I wanted to ask if General Schriever would add to John's answer on the military side. The question is, how do you compare President Bush's space policy with President Clinton's National Space Transportation Policy? Does the new policy provide a vision for the future in space? And General Schriever, the question wasn't about military space, but what about Clinton? There's really been a vacuum on military space policy, I think, so perhaps you could both comment on that.

DR. LOGSDON: The Clinton Administration policy statement on space transportation of last August is a very good, forward-looking policy statement. It gets the roles right. It says that the pressing need to be in space is national security and that DoD will have the lead in making our current ELV fleet as good as it can be and have the responsibility for upgrading it, and it gives NASA the technological challenge that NASA is supposed to be able to accomplish—to do leapfrog technology.

To compare that to the Bush transportation statement is not realistic. We've been debating national

launch policy for 12 years, and I think the Clinton statement is a good one—if we can execute it.

MS. FOLEY: General Schriever?

GENERAL SCHRIEVER: Well, I don't know specifically about the transportation policies that have been stated, but I know from the standpoint of national security. I mentioned that one of the most vulnerable things we have in being today is the spacelift capability of the national security satellites. We have two locations, Vandenberg and the Cape. They are highly vulnerable. They're not threatened now because we don't have any immediate active threats. But we're going to have to go to smaller satellites, smaller spacelift capability, and mobile capability. Small satellites, mobile capability for launch.

We use the same technology, for example, for commercial aviation as we do for military air. But the equipment is quite different, and I think space is going to diverge to some extent that which is necessary for military or national security needs as compared to what is available or necessary for civilian applications.

MS. FOLEY: I have several questions that are not addressed to Steve Dorfman, but he's obviously the person to answer them regarding Spaceway and direct broadcasting. I don't want this session to get technical, but they tend to ask a question about propagation delay of the signal and whether there will be some problem with video and voice not getting instantaneously transmitted. And then another question about whether direct broadcasting will ever be as interactive and expansive as proposed fiber optic cables. So, perhaps Steve, you could just talk for a minute about how Spaceway and the futuristic services that new satellites are going to provide are going to operate and whether there are technical flaws that have to be overcome.

MR. DORFMAN: Well, in the direct broadcast to the home, the systems we have now are interactive. And the way they interact is we have high band with video coming down in a broadcast sense and a telephone line feedback. I think that's going to serve some 97 percent of the needs for interactivity in the future, whether the medium is cable, fiber, or satellite. And that is because most people only need very low data rate out and high data rate in.

In the case of the time delay, it's not a technical issue. It's really a consumer issue. And that is because geostationary satellites, when used for two-way communications, do have a slight time delay, which some consumers will accept and others won't. The delay relates to the velocity of light and the fact that it takes a quarter second for the communications to go round-trip. In telephone conversations that's an impediment for some people. But it's one that people will live with when there's no good alternative. Around the world, as we get more and more fiber optic and landline capability, people will gravitate to the landlines for telephone conversations as opposed to satellites. That's going to happen as long as the service is there and it's economical.

With mobile communications, it has now for the first time become technically and economically feasible to communicate voice via satellites in low Earth orbit, because you don't have to have tracking dishes. So for now, for the first time, using the hand-held mobile systems I talked about earlier, we have choices. We can go at low Earth orbit, about 1,000 kilometers; at mid-Earth orbit, about 10,000 kilometers; or at geostationary orbit. Each system has its own attributes and economics, and we're now engaging in a new, and I think very fascinating, commercial endeavor in which consumers will be able to choose which of the three types of systems best suits their needs. Iridium and Globalstar will be in low Earth orbit, INMARSAT-P will be in medium Earth orbit, and the geostationary satellites will continue as they have before. I believe all can co-exist in the marketplace.

With mobile communications, it has now for the first time become technically and economically feasible to communicate voice via satellites in low Earth orbit, because you don't have to have tracking dishes.

I think that by the end of this decade we're going to have all three types of systems, and consumers will have new technologies to enjoy and new choices to make. Hughes' bet is on medium Earth orbit satellites and geostationary satellites for mobile telephony applications.

MS. FOLEY: And we have time for one last question. I'm going to read the question from the audience, then change it a little bit I think. I'd like to direct it to Tom Rogers and General Schriever. If anyone else wants to comment too, please do.

Everyone agrees that the U.S. needs a new medium lift space launcher. ARPA has a proven method of developing low-cost commercially competitive small launchers, Pegasus and Taurus. The questioner didn't add this, but ARPA's out of the space development business now, so they're really not a player. Why not follow that model instead of having the Air Force pursue EELV and NASA the reusable launch vehicle? My twist on the question is EELV and the reusable launch vehicle: a) Is it really going to be a launch vehicle and b) is it going to get you what several of the panelists have said is the number one priority in getting the space program jump-started?

GENERAL SCHRIEVER: First of all, I think we have done a lousy job in the launch vehicle area. We've really upgraded the ICBM program, the Atlas, the Thor, and the Titan. We need to think bigger. We need to have a completely reusable system that, from a technical standpoint, should be given optimum support. From a military standpoint, we need mobility in our systems. And we need to reduce the vulnerability of our ability to launch satellites in a wartime situation. I didn't get a chance to get into that in any more detail, but I think by civilian requirements the EELV may be effective. It might reduce costs by a factor of two or maybe three, but I doubt it. I think we have to use new technology, new ways of thinking. We can't have a satellite standing on the pad like a research activity and taking three to four months to launch. We've got to change our thinking with respect to the whole business of launching.

MS. FOLEY: OK, that's the warfighter's opinion. Tom?

MR. ROGERS: I'd say two things. Jack Gibbons' National Space Transportation Policy paper. I agree with John. It's a good piece of paper. It's probably the best one in this area that I've ever seen. I think they probably went about as far as they could, Theresa. You know, life is complicated in D.C. and I think they probably advanced the ball as far as they could.

Over the next five or 10 years it's going to be ELVs and the shuttle, and if the military can squeeze a lot more onto the ELVs quickly and sensibly, I think that will help them. It will help the commercial side, short term. But I'm with Ben. We've got to get those orders of magnitude and this means the reusable vehicle. We should be going like hell at it.

MS. FOLEY: Steve, are the EELV and the reusable launch vehicle going to solve your launch vehicle dilemma?

MR. DORFMAN: I'm fascinated with the potential opportunities the RLV offers, and I think NASA's now proceeding to invest in the technology. I think that's good. I believe that we do need to do a little bit more investigation about how it will ultimately be funded. I think it's optimistic to think the commercial sector will move in to fund a multibillion dollar investment, so I think we need to sharpen our thinking regarding funding.

I emphasized in my talk that we need a new generation launch vehicle that will benefit both the government and commercial programs. To think that a new launch vehicle would be funded exclusively on a commercial basis, when over half the launches are still government launches, is, in my opinion, idealistic and impractical. But I believe that by properly combining government and commercial interests, we have a real opportunity to get a good, strong U.S. expendable launch vehicle industry going again—one that we could claim, with integrity, positions us in a leadership role in launching satellites.

MR. ROGERS: As Steve is able to articulate today, the market possibilities in the information areas are enormous. The whole field is yeasty. But in the non-information areas, we've got to learn how to generate wholly new markets. And that should be going on in parallel with the technology development and the thinkings about operations.

MS. FOLEY: Thank you, Tom. I want to thank the panelists for them, they've done a wonderful job. Thank you for being so attentive. I think Dave Payne may have an administrative announcement or two to make and the coffee break will start in a minute.

MR. PAYNE: Thank you, Theresa, and also to your distinguished speakers for providing us with such an informative session. At this time we will be taking a fifteen minute coffee break. We will reconvene at five minutes to twelve, or twelve o'clock it looks like now. Thank you very much. This coffee break is sponsored by Spaceport Systems International. Thank you.

Remote Sensing: The Emerging Era

Master Moderator: **David L. Payne**
Manager, Spacecraft Technology
TRW Space & Electronics Group

Speakers: **Prof. Joanne Gabrynowicz, J.D.**
Director of Graduate Studies
Professor of Space Law & Policy
Dept. of Space Studies
Center for Aerospace Sciences
University of North Dakota

John Morgan
Director General
EUMETSAT

Dr. Vernon H. Singhroy
Senior Research Scientist
Canadian Centre for Remote Sensing

Dr. Murray Felsher
President, Associated Technical Consultants
Director, North American Remote Sensing
Industries Association

Robert Winokur
Assistant Administrator for Satellite and
Information Services
National Oceanic and Atmospheric Administration

MR. PAYNE: Our next session will look at the emerging era of remote sensing and its benefits to and impact on our society. We're fortunate to have with us today Professor Joanne Gabrynowicz who will be chairing the session. She is a professor and an attorney. She's a professor at the University of Space Studies at the University of North Dakota. Professor Gabrynowicz teaches classes in space treaties and legislation, space policy and international implications, and remote sensing law and policy. She has a number of published papers on these subjects. As a sidebar, the University of North Dakota offers the world's only Master of Science and Space Studies degree and has produced approximately 150 civilian and Air Force graduates.

Professor Gabrynowicz is a member of the International Institute of Space Law and the Congressional Office of Technology Assessments Earth Observation Advisory Panel. She is currently a member of the National Research Advisory Group on Transporter Data Policy.

Please join me in welcoming the moderator for our remote sensing session, Professor Joanne Gabrynowicz.

PROFESSOR GABRYNOWICZ: It's truly an honor to be here today, and I want to thank the Foundation for giving me this opportunity. When I was racking my brain looking for the obligatory humorous story that you have to have to open up one of these conversations, it dawned on me that truth is often funnier than fiction, and I came up with two recent real-world examples of that. A couple of months ago, I received a phone call from the Los Angeles Police Department. They wanted to know, interestingly enough, if there just happened to have been a satellite over Los Angeles about midnight mid-June last year sometime and would it see a white vehicle.

The second story has to do with teaching my current Air Force classes, which have 33 officers in them, many of whom are missilears and bomber pilots. I was reporting to them I had just come back from the Goddard Space Symposium where I heard General Doolah tell us all about Talent Keyhole and the fact that we were now allowed to look at these images in a nonclassified environment. The sound that I heard were 33 jaws dropping simultaneously. I wrote Talent Keyhole on the board and one of my officers said, "You're going to erase that, right?" And I said, "No, I don't have to."

These stories are important, not only because they really happened, but also because they demonstrate the changing culture of the remote sensing environment. The first story demonstrates that you can have a highly technological community like the police department, which is very used to high-tech possibilities for criminal investigation and still does not have a clue about what a satellite is or what it does. The questions I was asked demonstrated that if I asked this fellow to draw a satellite for me, he probably would have drawn a little grapefruit size ball with sticks coming out of it. The second story demonstrates that the dynamics of policy, law, and technologies are changing so much that they really would be hard to protect, and I wouldn't try to guess that.

But at this point, I think in the future of remote sensing, three things do seem to be certain. First, there is a growing diversity of opinion about remote sensing. Gone are the days when we can expect lock-stock opinion of what it does, who should have it, and where it should be originated. I think today's panel will reflect that. We have representatives from Europe, someone who knows about the developing world and industry.

The second thing I think we can count on is that remote sensing is inviting U.S. to seriously consider the proper relationship and most efficient and most economic relationship between the public and the private sectors. In Europe, there is a viewpoint about the relationship between the public and private sectors that we engage in here in the United States, and it is quickly becoming—if not already has become—a major policy question at the heart of global activities.

In the United States we have a situation where the current system, the LandSat system which was originally a public sector system, is aging, is on the verge of not being able to return any images in the near term, and we don't yet have a private system flying as hopeful and as promising as they do seem to be. So the United States has a particular interest in dealing with this relationship as we speak. In Russia, who knows what's going on? It's another major remote sensing agency, but the entire turmoil of going over to a market-driven economy certainly is going to affect remote sensing as it does everywhere else.

The third thing that will definitely be a certainty in the remote sensing future is what I call dual-use data. In the Cold War, our difficulties were around dual-use technology. In the post Cold War, our issues are around dual-use data. It has value for both economic and commercial as well as scientific and research purposes. Unlike dual-use technology, where the issue was who gets the technology, dual-use data raises the issue of by whom should the data be distributed. And it's an issue that will not go away and will continue to develop as we go along.

As you add on top of that the high resolution capabilities that are becoming available to the marketplace, we might call it tri-use data. The military effectiveness and the military importance of data will also continue to be an important issue.

This also is going to be an important issue because the value-added industry in remote sensing is currently being driven by the phenomenal breakthroughs in computer technology and software technology. That industry is growing by leaps and bounds and is one which will invite U.S. to consider how quickly data can be made available to people in real time around the world. Data is quickly becoming like smoke, but how do you catch it?

With that in mind, I'm going to go to our panel, because we definitely have a panel of very informed people who I think will give you some very good things to think about. Unlike Theresa, I'm not a member of the fourth estate, so I can't threaten to write about you or not write about you. However, I am a lawyer, and if you go over time, I'll sue you.

The first person I'm going to invite to come up to the stage is John Morgan. He's the current director of EUMETSAT, the European organization for meteorological satellites. Mr. Morgan has enjoyed three distinct phases in his career in the general field of operational meteorology: operational weather forecasting, computer systems, and satellite meteorology. In operational meteorology, Mr. Morgan worked in the forecast office within the UK and in northern Africa and in areas of what is now known as Yemen. And I'm about to nominate this next sentence for the absolute best sentence I have every come across in a bio. "This proved to be an experience of tremendous value. It is very character forming to be told that the safety of an entire squadron of military aircraft flying in close formation depends on your accurate forecast for 12 hours hence."

By 1976 the satellite meteorologic branch of the UK setup a computer processing screen for the UK instrument stratospheric sounding unit to be flown on the polar orbiting satellites of NOAA and the United States. In 1977 Mr. Morgan moved to Germany and helped in the working group that eventually set up EUMETSAT for which, in 1986, he was elected as its first director. So I'd like to introduce you to Mr. John Morgan.

In the Cold War, our difficulties were around dual-use technology. In the post Cold War, our issues are around dual-use data. It has value for both economic and commercial as well as scientific and research purposes.

MR. MORGAN: Thank you very much, Joanne, for that introduction. It is true that the experience you mentioned is character forming. I'm not sure whether the character is positive or negative as a result, but it certainly made me think.

The meeting has been very interesting so far. There's been a lot of vision statements, what's going to happen to the future of space, man in space, and so forth. Now we're focusing more on the applications area. There is little vision about what I'm about to tell you. I'm about to talk about what we're actually planning, the reality of one application area. And the application area is meteorology and climate studies within the general application of remote sensing. If I could have the first slide please. *(Fig. RS-1)*

EUMETSAT is an intergovernmental organization. Our members include 17 countries in Europe. One of the interesting aspects of working in such an organization is that we have to persuade 17 governments every time we want to start something new. So I don't have much sympathy with your problems here in the United States when you only have one.

But we do have 17. So far, they've all managed to agree on our programs, and perhaps we should stop soon while they're still agreeing. If I could see the next slide. *(Fig. RS-2)*

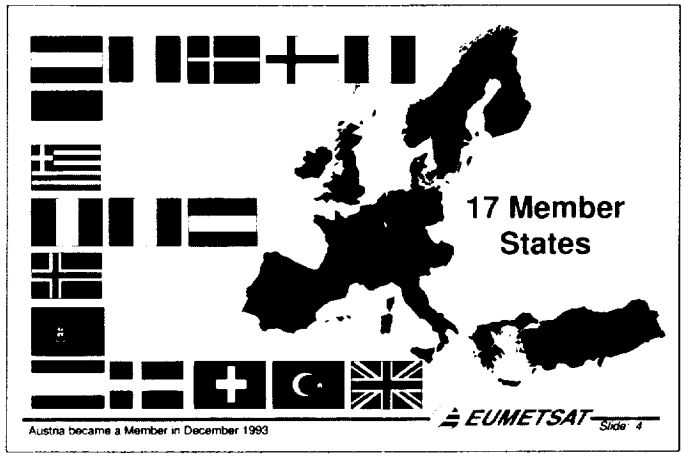
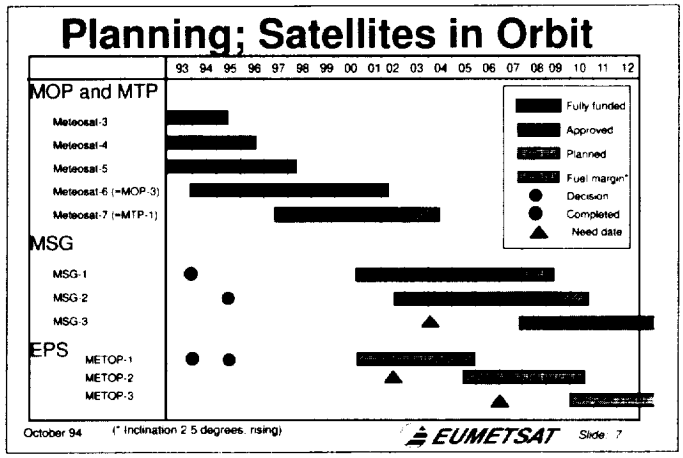


Figure RS-1



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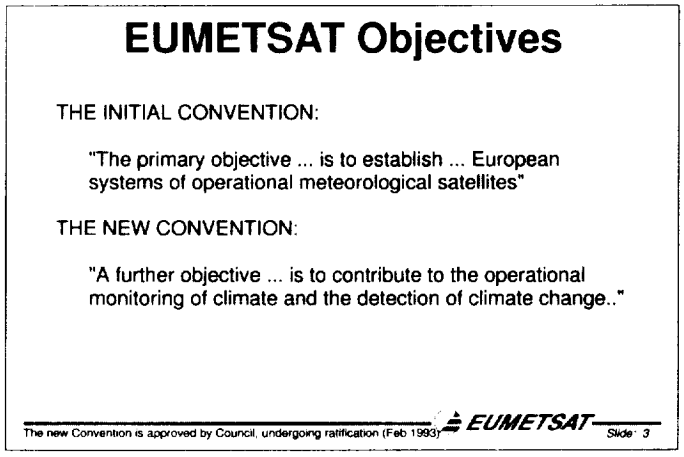


Figure RS-2

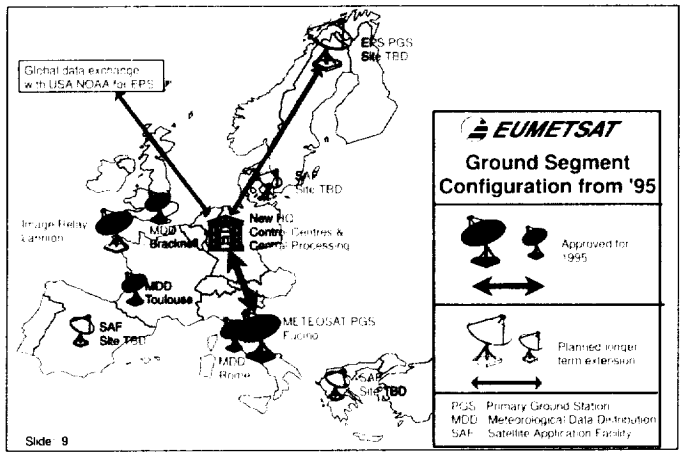


Figure RS-4

To say something about our objectives, our mission statement. What we are about is in the first line. We are to establish European systems of operational meteorological satellites. Those are satellites intended to support weather forecasting. But we also have a secondary objective. We know that weather satellites are useful for climate studies and detection of climate trends, and therefore we have formally added to our mission statement a need to contribute to the operational monitoring of climate. So those are the two things we're trying to achieve with our operational systems. If I could have the next slide please. *(Fig. RS-3)*

That's the planning that we have to do that. The first half of the slide showing the Meteosat satellites are those which are of the current generation, the first generation of European weather satellites. They're all geostationary satellites. Their frequent images cover the whole of Africa, the whole of Europe, the Middle East, and most of the Atlantic. You can see, if you look at the chart carefully, that we plan to have at least two of those in orbit at any one time. In fact, we have four operable satellites in orbit now and that is a feature of the system used for launching satellites. I'm very anxious that some of the ideas discussed on day one come to fruition so we have more efficient systems of launching. We have to plan so far in advance of launching a new satellite, we're never quite sure if the old one is going to be operable or not when we get there. Consequently, we've got rather a lot in orbit at the present time.

The present satellite systems, that's up to Meteosat-7 there, will give U.S. data continuity until the end of this century. Then we've already got funding for the next generation, MSG, Meteosat Second Generation. It's a new development which has been authorized and approved. We have funding for all those satellites, which means the 17 countries that I mentioned have agreed a program envelope of the money needed to prepare the satellites, launch them, and operate them up until the year 2012.

So although this is not a vision statement, we do plan quite a way into the future, and we do have the money in hand to guarantee geostationary data coverage until well into the next century.

The third batch of satellites there, EPS, or EUMETSAT Polar Systems, is our new proposal for the polar orbiting system to match those presently operated by the USA. In fact, we're doing it in partnership with NOAA, and we expect to have a new

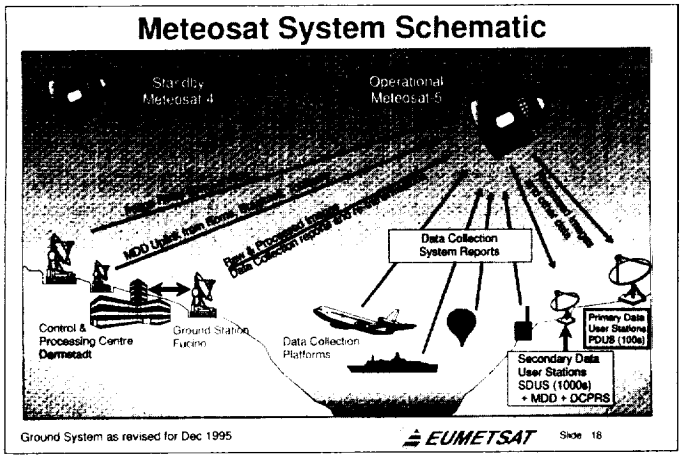
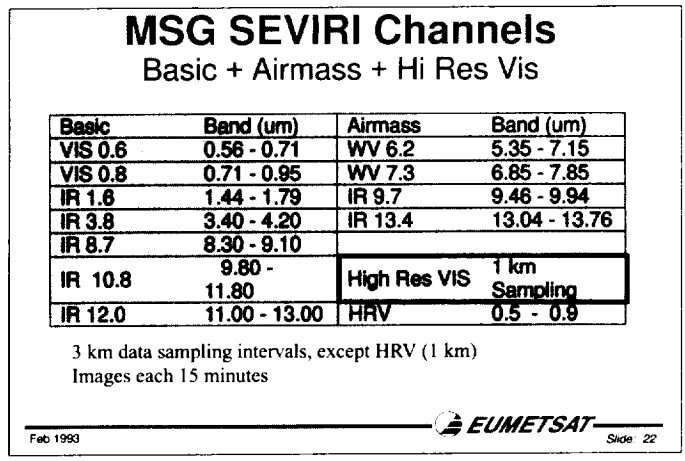


Figure RS-5



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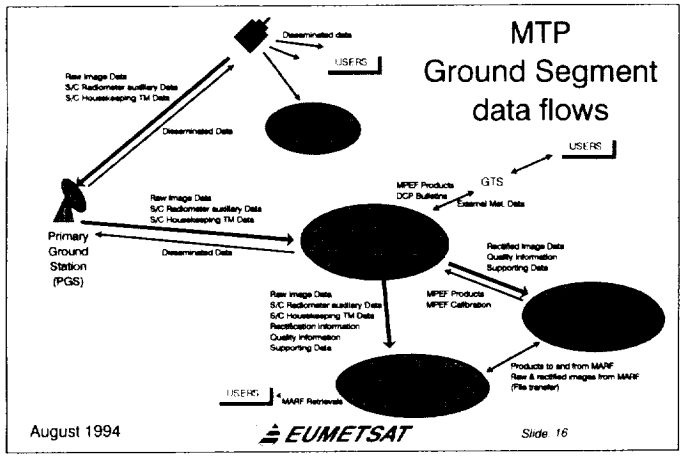


Figure RS-6

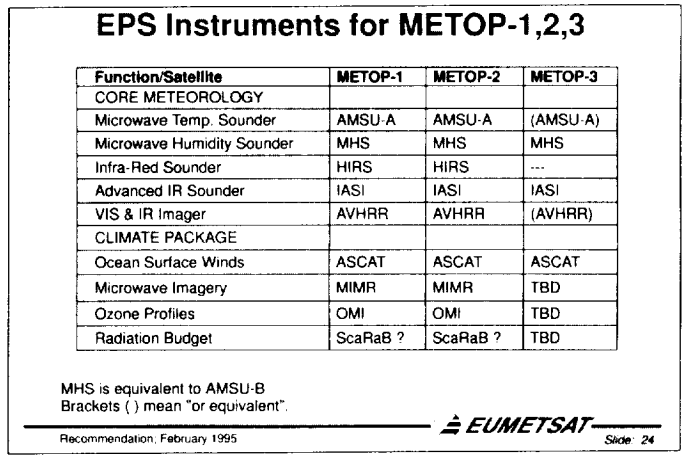


Figure RS-8

satellite of that class operable from the year 2001 and expect to have continuity of operation from that series to give U.S. a full system of satellites in both geostationary and polar orbit for two classes of observation.

Beyond 2012, well, we shall see. I would expect to continue those two streams of satellites, geostationary and polar. Perhaps we would split them into smaller missions so that we have even more satellites beyond that date. So let's move on to the next slide, please. *(Fig. RS-4)*

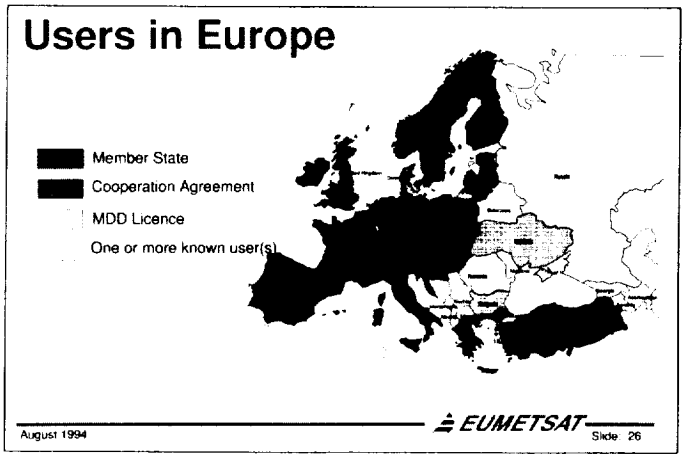
As well as the space segment, we have a ground segment reflecting our international status. Most of the processing is done in Germany where I work, but our main ground system is being refurbished, and we have a new ground station in Italy as well as substations in France and UK.

Moving on to the next slide *(Fig. RS-5)*. This shows a diagrammatic of the systems that we have in operation, showing the number of missions that are associated into the satellites. I won't go into detail, but I think the main mission is that we distribute to some thousands of user stations images every half an hour, day and night, throughout the year. Next slide *(Fig. RS-6)*.

These are the details of the mission, but I won't dwell on them. I've just been told that I have five minutes to go, and I have a few more things to say. So next slide. *(Fig. RS-7)*

This gets down some real numbers for our next generation. Our present satellites have three channels, and they image the Earth over the area I mentioned every half an hour. Our next satellites will have 12 channels imaging every 15 minutes. The channels on the left are for looking at clouds on the surface of the Earth. The channels on the right are mainly to look at the atmosphere itself. So this is a meteorological satellite with extensive climatological capabilities. There's not much left to know about clouds once you've got this flying and can monitor the evolution of cloud systems, as I said, every 15 minutes, across the whole area of the Earth disc. Next slide. *(Fig. RS-8)*

Our polar satellite is going beyond the trend mentioned this morning of only having small satellites. Mentioned several times, perhaps this is the last of the big ones. But our plan at the present is to have a very capable satellite system with all those instruments mentioned on the lefthand side flown on the same satellite. The first batch of instruments are those operational instruments presently planned to be flown by



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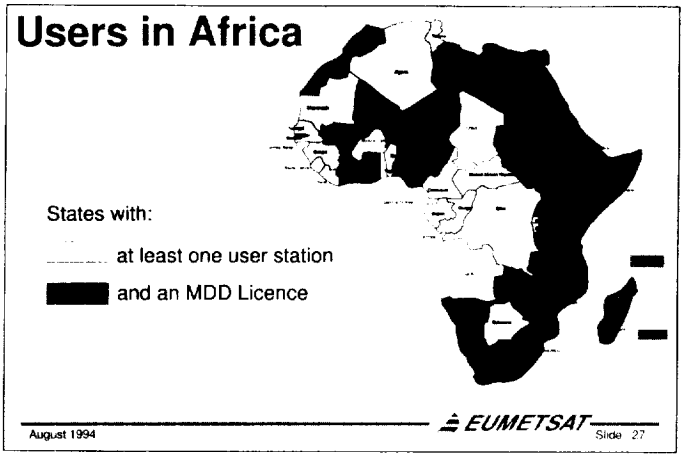

Figure RS-10

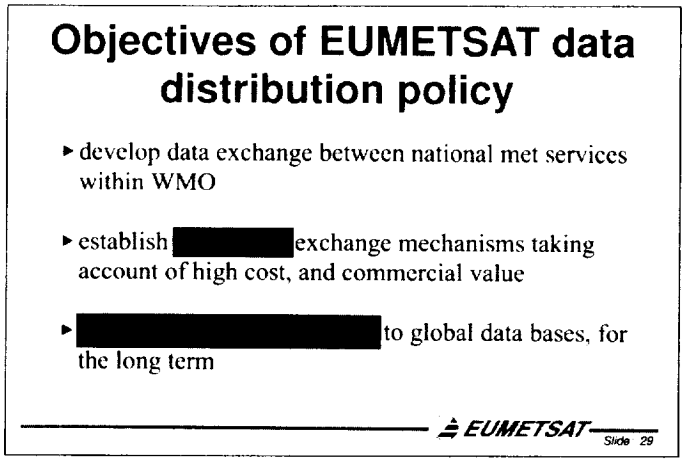

Figure RS-11

NOAA in the same time frame, with the addition of an advanced infrared temperature sounder which we plan to develop in Europe.

The next set of instruments of the so-called climate package are those instruments which are new, all developed in Europe, which specifically look at various aspects of weather and climate. The first one gives U.S. the capability to measure surface winds over the ocean at intervals of some 25 kilometers. A very powerful, active radar system. The next is a passive microwave image, rather like the SSMI on your military defense meteorological satellites. And then we will monitor ozone and the thermal balance of the Earth's system with the last two instruments. So, those very capable satellites are due to be launched from 2001. We do not have funding approved for this system yet, but we are reaching a convergence on the instruments to be flown, and we hope this year to get authorization for the whole package to fly that until the year 2012 or a bit beyond. Next slide please. *(Fig. RS-9)*

To show you something of our user base, I show this slide which documents the EUMETSAT member countries. They, of course, get the data without restriction and without any further complication other than they fund the whole program according to their wealth. That is, Germany pays more than Ireland because it has a bigger gross national income, and the payments for the system are according to that GNP. Other countries do not pay according to such a scale. Nonetheless, in the last year since the opening up of the East, we have arranged agreements with the former eastern bloc countries so you see that we've got cooperation agreements with the Baltic states and the whole of eastern Europe. And even in Russia and beyond there are users of our system. Next slide. *(Fig. RS-10)*

Africa too is an area which uses this meteorological satellite data very extensively. Most countries in Africa shown in blue or yellow have a user station of some kind. Those shaded in blue also have a formal agreement with U.S. to receive one of the data missions that we provide, the meteorological data, which is a kind of pure communication system whereby we send meteorological products such as forecasts to those countries. These and other missions have been extraordinarily effective in Africa where their local communication systems are almost negligible. We've had people responsible for meteorological services in different countries in Africa coming to us almost with tears in their eyes because, using the systems that the satellite provide, they, for the first time, can get information from observing sites a hundred kilometers down the road. It's much simpler to use our satellite to transmit data, twice times 36,000 kilometers, than it is to have a local land line in many parts of Africa.

So, as the moderator is standing up, I shall go on to the next and last slide *(Fig. RS-11)* which is just a summary of the systems I've briefly mentioned, showing that we are providing continuous data coverage in geostationary orbit until at least the year 2012, and we're planning polar observations for the same period. Thank you for your attention.

PROFESSOR GABRYNOWICZ: Thank you, John. Our next speaker is, very appropriately, picking up where John just left off. We're very fortunate to have him

today. He is going to offer U.S. a viewpoint that we don't hear about quite as often. Dr. Vernon Singhroy is a Senior Research Scientist at the Canada Center for Remote Sensing in Ottawa, Canada. He received his Ph.D. in environmental and resource engineering at University of New York, Syracuse.

He has published extensively on the use of remote sensing and resource management in areas within and outside of Canada. Dr. Singhroy has conducted remote sensing projects in Guyana, Brazil, Jordan, and the Caribbean basin. He also advises Canadian foreign aid and international research agencies on projects related to the utility of remote sensing in developing countries. Dr. Vernon Singhroy.

DR. SINGHROY: Thank you very much, Joanne. Over the past 20 years in this business, I have travelled in many developing countries and I'll share of my opinions here vis-a-vis the utility of remote sensing. What I plan to do in 10 minutes is just to review briefly the needs, applications, opportunities, and some of my thoughts.

Over the past 20 years, our use of remote sensing is slower than we think based on some of our current experience. I cite two statistics here, one in relation to food in Africa, and one on the case of deforestation for which we have a lot of statistics. There are other topographic maps and ground water and so forth. But there is a problem, a global problem, very acute in the developing countries.

There is a serious need to strengthen and upgrade current remote sensing (RS) and geographic information systems (GIS) to meet the current environmental monitoring and natural resource management needs in developing nations. Although these technologies are used routinely by government agencies and private industries in developed nations, their utility in developing nations is limited. Full integration of RS/GIS technologies in the institutional infrastructure of developing nations can only be realized through staff training, the development of skills through pilot studies, the supply of equipment for operational work, followed by timely maintenance, and long-term data supply. If the above requirements cannot be fulfilled, it is better to postpone the development of operational RS/GIS capability.

If you want to develop a market, remote sensing, and GIS capabilities, the technology transfer, in our opinion, takes more than 10 years. And if we want to rely on donors, the World Bank, and, in our case in Canada, CITA and so forth, these donor agencies usually commit leverage funds only for five to 10 years.

Some developing countries are becoming very sophisticated, and you see some hot spots in the world like India, Brazil, and a few other countries. As a result of that, one has to compete with those countries. The value-added services from developed nations are also increasing because of the GIS and image processing facilities.

Remote sensing provides a lot of information with regard to improved mapping, assessing and monitoring natural resources, land use, land degradation and hazards. There's thousands of case examples within and outside of the developing and undeveloped world.

Because the resource information base in developing nations is insufficient, remote sensing technology is very important. An important point to emphasize is that the economies in the developing world are mainly based on fishing, agriculture, forestry, and mineral resources, so you need that resource base which remote sensing can provide.

We've had people responsible for meteorological services in different countries in Africa coming to us almost with tears in their eyes because, using the systems that the satellite provide, they, for the first time, can get information from observing sites a hundred kilometers down the road.

We hear a lot that global problems need global solutions. Remote sensing and GIS are essential in the global food security, particularly in developing nations. We've seen examples in the press of this. And a very important point if we want to talk about policy in a real sense is that developing countries do not have the capabilities to compete and to maintain resources inventory because they need a micro management view apart from the scientific macro view on global change. If you're going to do that resource management, we obviously have to make sure that we have a fairly accurate inventory of the land mass of the world.

Market forces will decrease the price of satellite data, thereby increasing the use in developing countries. There is always a question of price, and a number of countries in the developing world feel that satellite data is very expensive. But as we have more competition, this obviously facilitates the price.

The full potential of remote sensing is through data integration. It's very, very important, and here I'll show you some examples. I'm looking here at the multifaceted approach of electeroptical and radar data and GIS information, and I'll throw some pretty pictures at you just to have a feel.

As we zero in on a micro level to look at the detailed mapping of inventory, we can look at the dissection of the landscape—just zero in on the detailed scale where we can provide GIS, again using the electeroptical systems of the thematic or spot data and imaging radar that provides the cloud-free imagery that gives you the pseudo-stereo or topographic

coverage you need to look at other aspects of the resources.

Now we always have to look at the market; we have to look at our client. Basically there are two clients in the developing world. One, the government, and two, the private sector. Government programs require—and I underline that—large volumes of electeroptical Earth observation data, radar data, and so forth, particularly for regulation and for public good processes. The private sector, on the other hand, are clients that use the remote sensing to gain the commercial advantage, the value-added services, and so forth.

Market forces will decrease the price of satellite data, thereby increasing the use in developing countries.

We are launching Radar Sat in the fall, and as a result, we will have a fairly extensive program flying approximately 15 to 20 countries—over 40 test sites—trying to educate the user in technology transfer pilot programs and so forth. As a result of training these countries will know how to use imaging radar in their day-to-day activities at the micro level or at the regional level. This Canadian GlobeSar program is obviously a data acquisition for Sar data, training and technology transfer, to hone in on the market. It is led by the agency I work for, the Canada Center for Remote Sensing, in cooperation with the Canadian Space Agency and the Canadian and Radar Sat International, basically about 40 sites from a number of disciplines.

Here are a few pretty pictures, showing examples of GlobeSar and particularly distressed integration and the multifaceted approach of localized remote sensing (figures unavailable). Here we look at the coastal areas of Guyana where you have a LandSat thematic mapper draped over a Sar imagery. In that particular area, for the 20 odd years of LandSat program, that's the only cloud-free imagery we've got. Particularly for global change, look at the flooding. There's a billion dollars in the coastline for degradation of land at sea level ranges and so forth.

Here is the same area again looking at the LandSat thematic and various enhance programs and degradation of the environment apart from providing information in near surface coastal areas and coastal patterns of the water.

Here's an example of detailed land use classification, from over-cut forests to degraded land to agricultural land use and so forth, whereby these can provide the developing world, in this case Guyana, with land cover information for that result from agenda to anyone from the real conference.

Satellite remote sensing is obviously needed for sustainable development and environmental protection in the developing world. And to follow up on what Dr. Córdova, NASA's chief scientist, said last night, the space community needs to foster and strengthen our ties. I think we need a four-lane highway here going back and forth to the developing world and in the developed world providing training, technology transfer, pilot programs. These are time consuming processes. We need to train the groups in the developing world because through training we can foster a more global and commercial program. Thank you.

PROFESSOR GABRYNOWICZ: When we were planning this session, I talked to Vernon about it and he gave me some very interesting statistics, one that I would encourage anybody interested in commercial opportunities to do a lot of homework in. For example, the entire remote sensing budget, national budget, for Guyana is $50,000 a year. So there has to be some real marketing done.

Also, the other thing, it would appear the threats of lawsuits are more effective than the threat of not being written about because we're on time. Our next speaker has threatened not to be on time, so I'm warning him now: Be on time. We're inviting up to the podium Dr. Murray Felsher who began his career in remote sensing, is a graduate and research teaching assistant in Photogeology at the University of Massachusetts at Amherst, and received his Ph.D. from the University of Texas in Austin. He taught graduate and undergraduate courses in oceanography and geology at Syracuse University. He has a very long and distinguished career in both the public and the private sectors, including working at EPA and NASA. He worked at NASA Headquarters as chief of Geological and Energy Applications and in the private sector he has been a consultant. His clients include Eastman Kodak, Logicon, Ultra Systems, Orbital Sciences, and Eyeglass.

Since 1981, Dr. Felsher has continuously published the Washington Remote Sensing Letter, and he is currently the chairman of the American Society of Photogrometry and Remote Sensing Committee on Satellite Mapping and Remote Sensing. What he will be speaking to us about today is the industry viewpoint. He is the founding director of something called the North American Remote Sensing Industries Association, and I'll let him tell you what the acronym is because it gets badly battered. Dr. Felsher.

DR. FELSHER: Thank you, Joanne. My comments this morning are digests of a more complete presentation which I have submitted to the organizers of this conference for publication in the Symposium Proceedings.

THE NORTH AMERICAN REMOTE SENSING INDUSTRIES ASSOCIATION (NARSIA)

I appear before you today wearing a relatively new hat. The formation of the North American Re-

mote Sensing Industries Association, or NARSIA, is a rather recent event. Our first Annual Congress was held barely nine weeks ago, and it drew representatives from 62 companies covering the broad spectrum of data providers, hardware/software developers, value-added image information organizations, and commercial end-users. In fact, this, the first effort to unite the common interests of the whole industrial body that deals with remote sensing products and services, was deemed a success. What I would like to do this morning is spend a few minutes (1) tracing the genealogy and current status of this activity, (2) outlining its charter and general purposes, and, perhaps most importantly, (3) substantiating the role of the end-user community in defining the ongoing applications of satellite and aircraft remote sensing.

The veritable lacuna that has served as government civil space remote sensing policy, since 1972, has made few look good and nobody proud.

Genealogy and current status: No attempt to trace the history of a remote sensing industries association would be possible without the acknowledgment of the prime relevance of the U.S. Landsat program. Most everyone in this room—certainly those of us involved in the Landsat program as government or private sector employees, consultants, media, principal investigators or academicians—are fully aware of the day-to-day travails, successes, failures, twists, turns, and fiascoes related to that program since the launch of Landsat-1 in 1972. The veritable lacuna that has served as government civil space remote sensing policy, since 1972, has made few look good and nobody proud. I will spend no time this morning certifying that random walk for you, but please believe me that it has been painful, trying, and altogether frustrating—for everyone concerned. The interim years from the then of global technological leadership and innovation accorded to the U.S. in this field—to the now, where the U.S. has been barely able to maintain a viable presence is, surely, an attestation to the penalty that will always be paid for muddled planning and hesitant implementation. That muddling is not only to be laid at the feet of the various agency and congressional entities responsible for our civil remote sensing efforts. Equally culpable has been (1) the lack of a unified industrial constituency willing and able to join together to undertake the necessary outreach activities aimed at those very same legislative and executive branch institutions and (2) the lack of a unified and vocal end-user constituency willing and able to certify the beneficial applications of remote sensing.

And so Landsat proceeded, smugly and blindly, from the Principal Investigator-based, NASA-ownership paradigm of the '70s, through the NOAA-owned-but-disavowed operational/commercial effort of the '80s, to the DoD/NASA-aborted engagement of the early '90s, to the recent NASA/NOAA/USGS shotgun marriage, and to the just-reported civil suit in federal court, brought by the current operator. This 23-year programmatic and bureaucratic dreamtime walkabout aside, the end result, insofar as Landsat is concerned, has been universal bewilderment—no more and no less. The U.S., certainly the global technological leader in satellite remote sensing—whether by wistful ignorance of plan or by whimsical circumstance of chance—has, just as certainly, abdicated that leadership. The French, the Japanese, the Russians, the Indians, and others, understanding that it is better to build and own a space-segment system than it is to rent and pay royalties for a ground-segment picture, single-minded, (and in some instances with U.S. government assistance), have all been steadily increasing their remote sensing smarts and market share, at the same time as they decrease the distance between themselves and putative remnants of U.S. leadership in the field. And mind you, right here at the outset, I make no apologies this morning in speaking for and seeking American predominance, both commercially and technologically in this most vital field of endeavor. I have no problem with international technological cooperation; I simply insist that the cooperation be fostered from a position of U.S. strength. In a time when U.S. technology is being inexorably rotated into an international mindset, including everything from the information superhighway to the ever-shrinking space station, I happily note that Cheyenne Mountain is still not yet under United Nations control.

I have no problem with international technological cooperation; I simply insist that the cooperation be fostered from a position of U.S. strength.

But I digress. The point is that for many years policy and laws related to civil space remote sensing were contemplated, discussed, considered, enacted, and promulgated without adequate input from that very industrial and commercial base that would be most affected by those policies and laws. As U.S. civilian multispectral scanner, thematic mapper, and AVHRR space imagery began to permeate through the international arena, in-country expertise and technology began to grow, and similar concerns as expressed here were being replicated by commercial and industrial entities overseas as well. In December of 1993 a group of European companies met in Geneva to dis-

cuss the formation of a users group. A formal structure for this European group, which now includes data providers as well, has been formulated at a meeting held in Paris on March 7 of this year. In February 1994 another group met in Melbourne with the same idea, and it is my understanding that similar groups are in planning stages both in Asia and in Latin America. We recognize the fact that the programs of each of these regional associations will reflect the concerns and idiosyncrasies of that particular region. In fact, the terms of reference of any one regional association might very well include specific principles whose tenets could be diametrically opposed to those of another regional association. If so, then so be it. There is nothing wrong with that, and, in fact, it is the major reason why any one international group of this sort would be doomed to failure. Make no mistake, international cooperation in the diplomatic sense notwithstanding, it is international competition in the commercial sense that makes the world go 'round, and I would rather it be U.S. satellite remote sensing commercial entities that dominate the global scene (no pun intended) than those of any other country. And that brings us to NARSIA's charter and purposes.

The majority, indeed the vast majority of otherwise sophisticated, well-educated Americans, are still wholly unaware of the phrase, "remote sensing." Nor are they aware of the benefits already derived from that activity and the expectations of future beneficial payoffs from satellites not yet launched.

Charter and Purposes: The well-attended First Annual Congress of the North American Remote Sensing Industries Association included breakout sessions which allowed the attendees to help frame the charter and terms of reference of the organization. More than that, the participants clearly validated the philosophical pillars that form the four underlying purposes of the organization. Briefly, and in no order of importance, they are (1) Government interfacing (2) Education and outreach (3) Marketing and (4) International interaction. Allow me to say a few words about each.

(1) *Government Interfacing*: The brief recital of angst related to Landsat that marked my initial comments this morning highlight but the tip of the proverbial iceberg familiar to all facets of our commercial and industrial community. And that community has indeed been moved to the hard realization and acknowledgment that in order to be effectively heard by those who enact laws and those who promulgate policy we must organize and bring together the whole sweep of activities that fall under the rubric of remote sensing enterprises. That is, NARSIA, to be a compelling force, must engage (a) those data providers who build and fly Earth-viewing spacecraft and sensors, (b) those commercial houses that write lines of code, and (c) those facilities that bend Earth-bound metal. These include industries that work in areas as diverse as space-segment command and control and ground-segment Earth stations. We must sign up those firms that take the "zeros" and "ones" emanating from the Earth station pipe and manipulate, enhance, and otherwise convert those numerical data into digital image information. We must sign up those firms that merge the digital image information with other disparate digital data sets to create a value-added image product. We must sign up those firms that analyze and interpret that image product in response to a specific requirement from a paying end-user. And again, perhaps most important, we must sign up those paying end-user entities that would purchase and employ the final remote sensing-based image product as part of their own commercial activity or intellectual pursuit. These are the members we seek. And with the breadth and depth thus acquired, NARSIA will be a telling force in placing forth the viewpoint of a constituency, *finally united,* to policy-making and law-enacting government bodies. NARSIA will prepare and distribute issue papers and white papers. We will testify before legislative bodies. We will serve on executive branch advisory committees. We will create a situation such that when an agency or a subcommittee is contemplating an action that deals with remote sensing, someone will always automatically say, "Get someone from NARSIA to provide us. with the industry's and end-users' point of view." And mind you, this is not being offered in any negative way. That is, we feel that both congress and the federal agencies, rather than working blindly as they have all these years, those bodies have frantically been seeking such an organization as NARSIA to provide them with the input they really need. And so, with the ink hardly dry on NARSIA's Terms of Reference document, we have already delivered a talk at last month's Goddard Symposium, and we're here today. We'll be speaking at the Fifth Annual Small Satellite Industry Policy, Regulatory and Financial Conference to be held at the National Press Club in Washington D.C. next month. In addition, we have been contacted by NASA to provide a full session of NARSIA member speakers for the upcoming NASA/NOAA/USGS-sponsored ASPRS Conference on Land Satellite Data Needs, scheduled for this September. And we have just learned that next year's U.S. Space Foundation national symposium, here at this venue, will include a major session comprising the international remote sensing industry associations, at which NARSIA will, of course, be proud to participate. Indeed, NARSIA

will provide coherent, cohesive, and cogent information to government agencies and all other audiences.

(2) *Education and outreach*: The majority, indeed the vast majority of otherwise sophisticated, well-educated Americans, are still wholly unaware of the phrase, "remote sensing." Nor are they aware of the benefits already derived from that activity and the expectations of future beneficial payoffs from satellites not yet launched. Yet, ironically enough, our remote sensing community has already had clear evidence of the impact of a strong, empowered public as related to remote sensing. I speak of the attempt by the Department of Commerce to privatize the U.S. meteorological satellite system, along with Landsat, back in the early 1980s. The ensuing public uproar prevented Commerce from offering up the metsats, even though by any measure the meteorological satellites were (and still are) far more operational than were the Landsat satellites. The difference was in the public's perception of the metsat data versus the esoteric, strangely colored Landsat imagery. Indeed, we need no "N E delta rho," signal-to-noise-ratio, IFOV techno-babble here. The public saw (and sees) metsat imagery on the six o'clock news. Cloud patterns, easily visible and recognizable, march eastward across the TV every day, right after the sport highlights and before the guy and gal anchors perform their nightly banter with the weatherman. Every day. And the public made its views known very quickly. That immediate and unequivocal public response crystallized the federal government's decision-making process—nearly instantaneously. And the metsats were taken off the auction block.

NARSIA will engage in whatever activities are necessary to bring the general public up a learning curve that culminates in an appreciation of remote sensing as a commercial exercise necessary to the good and welfare of the community at large. This will include all the classic tools, from newsletters to press releases. It will also incorporate the newer information dissemination devices as well, as the World Wide Web of the Internet. We do recognize, as did the computer industry early on, the value of early intervention, and so will participate in programs, as the NASA K-12 project that will bring space-derived imagery to the public schools via the Internet. A future voting public that became remote-sensing-literate as youngsters is a much more effective constituency than is the current adult voting public—one that must undergo very "basic training," as it were. In addition, NARSIA will engage in curriculum development for college and university classes to ensure a well-trained and continuous flow of professional talent into the technological workplace. And, as we grow, we plan to conduct in-service seminars so as to provide continuing educational opportunities for members.

(3) *Marketing:* NARSIA's third underlying purpose falls under the title of "marketing." Beginning with the 1984 Landsat Commercialization RFP issued by the Department of Commerce, many of U.S. have been engaged in providing what we would like to believe are sophisticated market surveys. These surveys, and the market research and intelligence that invariably accompanies them, purport to speak to the present status and expected future growth of the various GIS/remote sensing market segments as best perceived. In truth, and as a well-paid consultant and author of several of these studies, I must admit that they are little more than WAGS—Wild Ass Guesses. Those of us, who as consultants have guessed better than others have been rewarded with our growing client lists. This is satisfying in a pragmatic sense—after all, it will be paying medical school tuition for our youngest. But it is altogether unsatisfying in a professional sense. Until now there has been no real way of tapping into the actual resources of the remote sensing community as a whole to provide the quantity and quality of input necessary to build the kind of database that would truly define the remote sensing marketplace. NARSIA is attempting to show that by compiling such non-competitive, non-proprietary information as is resident in its member-company's databases, NARSIA will be able to construct, for the first time, a true picture of the marketing regimen now extant. Further, and more important, we will be able to predict, with much more certainty than hitherto possible, future market segment paths that will define our industry's growth. With each member company contributing its own portion of market survey, research, and intelligence, we will be able to construct a whole whose predictability, validity, and verifiability will be far greater than the sum of its parts. And so, as an internal exercise, NARSIA will serve as a central switchboard as well as a distribution point for market data and information from and to its members.

As we view the Earth from space, we are almost never able to perceive national boundaries. And to speak of imaging the Earth is to automatically recognize the global nature of that endeavor.

(4) *International interaction:* Lest you label me, in face of my earlier comments, as an atavistic, troglodytic isolationist, please know that I am none of these. Yes, the technology of remote sensing was indeed invented in the U.S. And yes, if the business of remote sensing were to be dominated by U.S. industry, I would not be upset. But the reality of remote sensing is its international aspect. As we view the Earth from space, we are almost never able to perceive national boundaries. And to speak of imaging the Earth is to automatically recognize the global nature of that en-

deavor. And as noted earlier there are several regional organizations being formed that may very well clone our own NARSIA efforts in other parts of the world. And even though we expect the U.S. commercial providers as EarthWatch and Space Imaging, Inc. to be the ultimate framework upon which will be papered supplemental government-provided space-derived data, it is fair to say that as of this date the only Earth-viewing satellites up there providing U.S. with imagery are government-owned. And here I include Landsat, SPOT, the U.S. metsats, Japan's MOS-1, JERS, ESA's ERS, India's IRS, and all the rest. Today, the world below is being viewed by a government-owned world above. As such, it behooves U.S. at NARSIA to not only be cognizant of that truth, but to also respond appropriately to its ramifications. Namely, NARSIA will provide whatever input necessary to CEOS—the Committee on Earth Observing Satellites—the governmental agency which serves as the international forum for space-faring, Earth-sensing nations. In addition, NARSIA will cooperate with any international, binational, or multinational organization seeking its input. In our role as the spokesman for the commercial, that is, nongovernmental remote sensing community, we feel that it is necessary for our own benefit, as well as any government's benefit, to be fully aware of the principals and points of view generated by NARSIA. As such, though NARSIA is indeed comprised of a very specific band of cohorts, with a very specific commercial agenda, we view remote sensing as a truly global activity, with benefits and responsibilities that exist beyond the geographic limits of its membership.

Remote sensing applications cross every major domain and discipline from agronomy to zoology.

NARSIA and the end-user community: Please believe that much of the turmoil and confusion permeating through government reports and policy statements is little more than semantic. There has been an inability, on all our parts, to provide a universally agreed-upon definition of a "user." Is a user the firm that purchases a SPOT image to which it will add value and resell? Is a user a federal government agency that trades its image tapes to a sister government agency? Is a user a GIS firm that purchases an image analysis package from a software house? Yes, indeed, they are all users, for if they are not users then what are they? But in terms of concern to NARSIA, and in terms of concern to our industry, they are not a user with an uppercase "U." There is only one kind of uppercase "U" user, and that is the End-User. How do we recognize him? Well, his first major characteristic is that he resides at the terminus—the far end—of the remote sensing chain. As we go from space segment to ground segment, and within the ground segment from the "zeros and ones" sliding out of the ground station, to a finished piece of image-based information, we indeed pass through legions of *using* entities and customers. However, the only REAL user is the fellow at the end of that long interactive purchaser-buyer line that pays for that final piece of image-based information. He's the end user, and he's the one that counts.

And that's the second major characteristic of the end-user, ladies and gentlemen. He pays. A service and/or a product is offered to meet the specific and stated need and requirement set forth. And the end-user accepts that service and/or product in exchange for cash. In kind of reverse phytoplankton-like, base-of-the-food-chain concept, it is the multitudinous end-user community that ultimately fuels the business, commerce, and industry of remote sensing. The building and launching of the spacecraft, the fabrication of the sensor, the construction of the Earth station, the integration of these systems, the writing of lines of code for ever-more sophisticated analysis software, and the technology explosion to accept that software into a desktop workstation—the future of all of this—insofar as is concerned the civilian commercial remote sensing industry—is in the hands of the end-user. An expanding, knowledgeable, and paying end-user community is the sine qua non for our industry. The feeding, comfort, and growth of that customer base should be our first concern. Though its existence will never ensure our success, be advised that its non-existence will certainly ensure our failure.

Remote sensing applications cross every major domain and discipline from agronomy to zoology. The very sweep of applications has been given as a prime reason for the inability of the industrial community to heretofore organize itself and aggressively move the business of remote sensing into the civilian commercial arena. And we agree with this assessment. But in the past this has led to little more than great sighs of neglect and retreat, by industry, to a fall-back position. And this fall-back position has always been the comfort blanket provided by the several federal agencies that make up the defense and intelligence community. Well, the world is changing. I am one who believes that the changes we have seen these last years, and those we can expect to see in the years ahead, will call for *more* comprehensive reconnaissance, monitoring, and surveillance activities by that established customer base. But I also know that a merchant that relies on but a single customer is one of two things. He's either foolishly ill-advised or he's ill-advisedly foolish. Budgetary and programmatic uncertainties notwithstanding, it makes no sense to recognize the impact that remote sensing has across the entire sweep of civilian applications, and not take advantage of the opportunities thus presented.

And so NARSIA has created a class of membership for the paying end-user, thus incorporating his

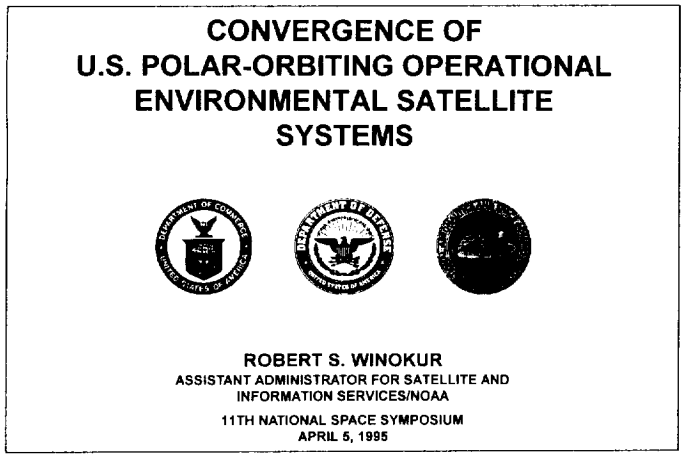

Figure RS-12

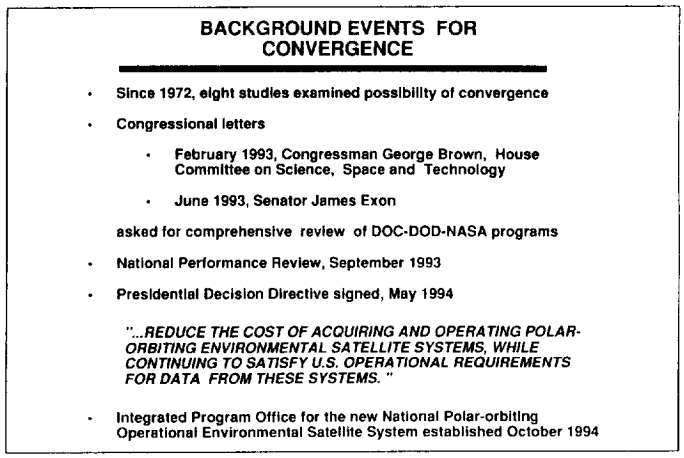

Figure RS-13

knowledge and expectations, and so ensuring ourselves of the timely and appropriate input by the membership dwelling at the front end of the space- and ground-segment food chain.

I look forward to as many of you as possible, both as individuals and as corporate entities, joining us. We seek your membership. We seek your support. We seek your help. In exchange for that support and that help, we will, together, grow an industry.

Thank you for your kind attention.

PROFESSOR GABRYNOWICZ: Murray, thank you. We have one final speaker, Mr. Robert S. Winokur. He's the assistant administrator for Satellite Information Services at NOAA, the National Oceanographic and Atmospheric Administration. He served as the technical director of the Navy, Office of the Chief of Naval Operations, and he was the senior civilian technical Manager for the Navy's Operational Oceanography program. Mr. Winokur has a BS degree from Rensselaer Polytechnic Institute and an MS degree from the American University. He has a number of published papers on his subjects and has received numerous awards, including the Presidential Distinguished and Meritorious Rank awards for senior executives.

Currently, Mr. Winokur is involved in activities concerning the dual use of technology and the application of Navy data and systems to environmental problems. Mr. Robert Winokur.

MR. WINOKUR: Thank you, Joanne. My vision for the future, if I was asked about two years ago, probably never included standing up here talking about the subject I'm about to talk about. Two years ago or so I was busy in the Pentagon trying to convince flag officers that satellite oceanography was an important element of what we did in anti-submarine warfare and support to Naval operations in coastal environments. But the world changes; my visions changed, and, so, here I am.

I want to point out two things with this introductory slide *(Fig. RS-12)*. This is a tri-agency program. It's dual use, I think, taken probably to its end because we are converging and merging a civilian system with a military system. I think that's very appropriate in today's world, and it particularly supports Vice President Gore's notion and vision for reinventing government. But more importantly, I'm the visible spokesman here today for an effort that has been undertaken by numerous people from NOAA, from the Air Force, from NASA, and the Office of Science and Technology Policy. So I am here as the lead spokesman and because I have the lead for putting it together. But I do want to tell you that a lot of people have worked to make this happen.

Next slide please *(Fig. RS-13)*. Since 1972 people had visions to make this happen. The vision got blurred somewhere along the way, and for numerous and valid reasons, convergence of the nation's civilian and military systems was not possible. It is possible today for a number of reasons, not the least of which is that both programs are in the early stages of a block upgrade. There was Congressional interest last year, followed by the National Performance Review in which the Vice President directed the agencies to take a look at putting together a plan to make polar convergence happen. That was then followed by a Presidential Decision Directive on May 5 of last year (1994) that directed the agencies to proceed to reduce the cost of acquiring and operating the nation's polar orbiting environmental satellite systems while continuing to satisfy U.S. operational requirements. A very, very important point. We opened our office for business, we got on with it on October 1 of last year, the beginning of the fiscal year.

The next slide is a very brief example *(Fig. RS-14)*. The civilian community has been flying polar orbiting satellites for many, many years. These data not only support the National Weather Service, but they're used for a variety of activities: climate studies, ozone, monitoring forest fires, and volcano eruptions to support FAA operations. When I was working for the

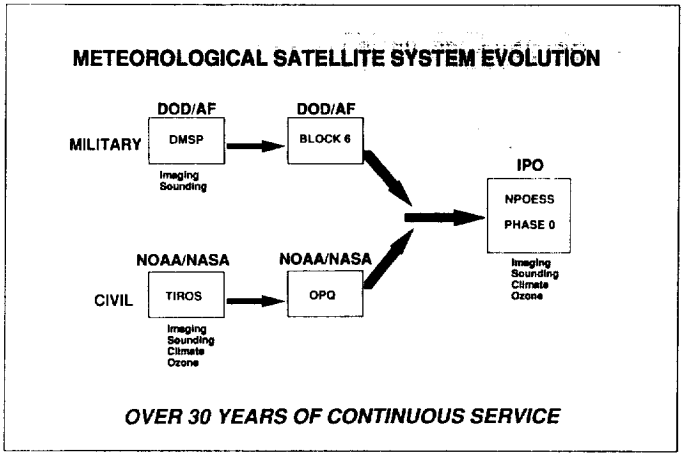

Figure RS-14

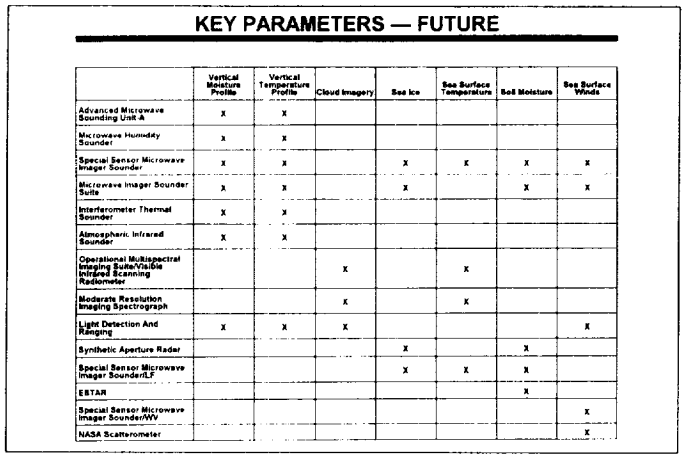

Figure RS-16

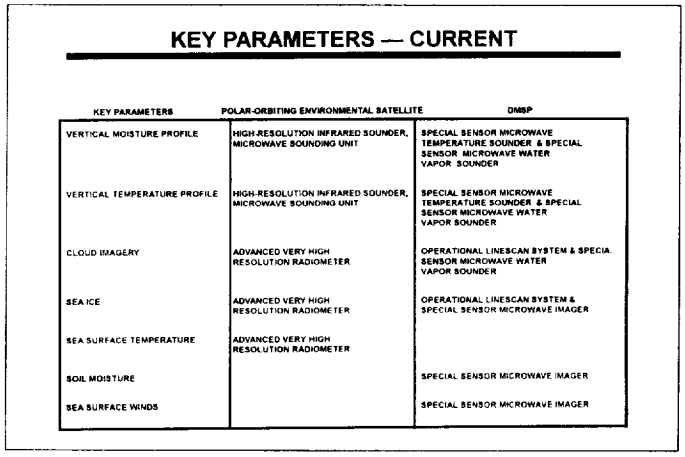

Figure RS-15

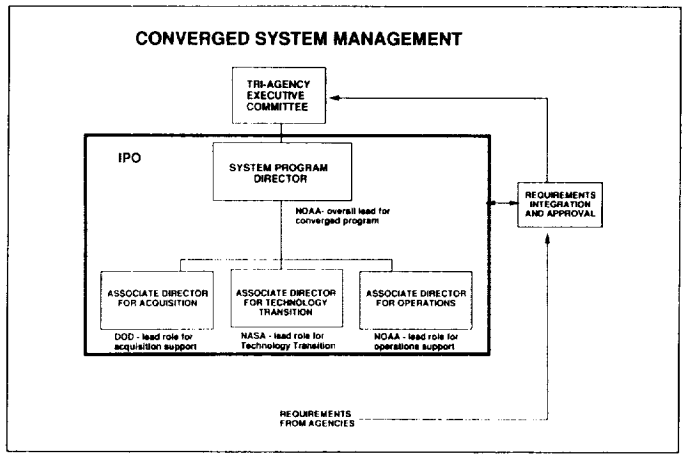

Figure RS-17

Navy, we used the NOAA sea-surface temperature data on a routine basis.

Likewise, the military relies very, very heavily to support its global operations on satellites for weather support. I was in the unenviable position a couple of times after Desert Storm trying to explain to various flag officers from battlegroups why we didn't do a very good job of predicting the weather over Baghdad. But we tried, and we tried to explain that it was a very, very difficult thing to do, but one has to clearly rely on the satellite information to do that, as well as in situ observations.

So where are we? We have 30 years of history of operating two separate polar-orbiting satellite systems in the U.S.—a military one and a civilian one. DoD was proceeding on a Block 6 upgrade in DMSP, NOAA was proceeding on a Block upgrade with its TIROS series and the O,P,Q series. The Presidential Decision Directive says take the two series, merge them together into something that we now call NPOESS, the National Polar-Orbiting Operational Environmental Satellite System and that's managed through the office I mentioned previously called the Integrated Program Office or the IPO. So we've taken 30 years of heritage, and we're combining it into a single national polar program. The next two slides show current and future key parameters *(Figs. RS-15,16)*.

We put in place a management organization that was outlined in the Presidential Decision Directive *(Fig. RS-17)*. We have a System Program Director, and I have the dubious distinction of being the Acting Program Director until we have a real person on board, hopefully very soon. That will be a NOAA employee. NOAA has the lead for putting the program together and housing the program. The Deputy Director will come from DoD.

This is a tri-agency program. We have three senior positions in the office. One is the associate director for acquisition. That person will come from the Air Force, and the Air Force has the lead role in providing support for acquisition. So we're using Air Force and DoD acquisition procedures, the 5000 Series, if you will. We have an associate director for technology transition. That person will be provided by NASA and will lead the way in our technology studies. And we finally have an Associate Director for Operations and Operations will be housed in NOAA and that person will come from NOAA.

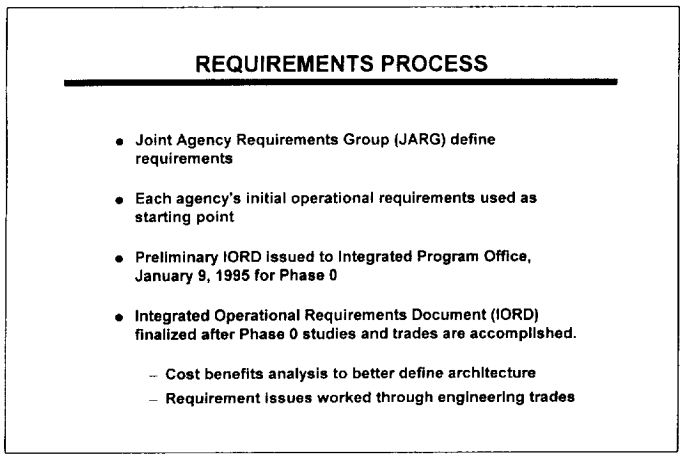

Figure RS-18

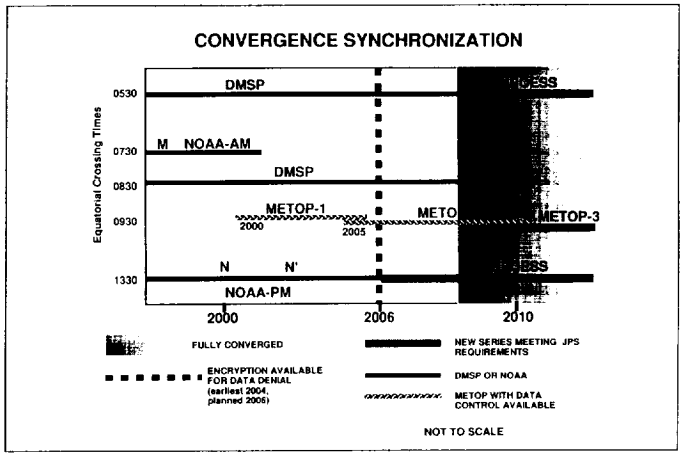

Figure RS-20

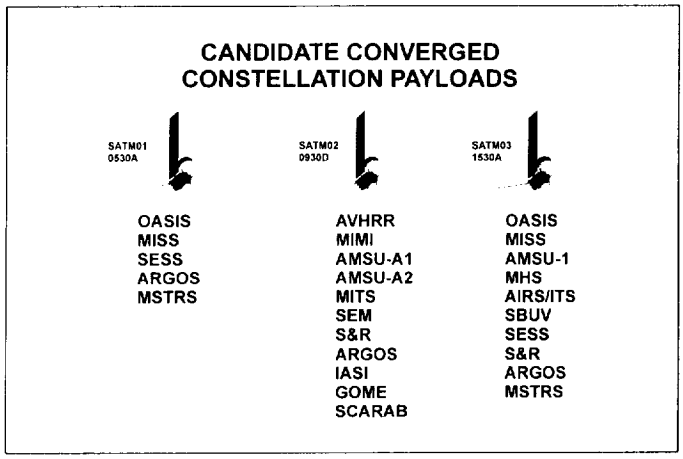

Figure RS-19

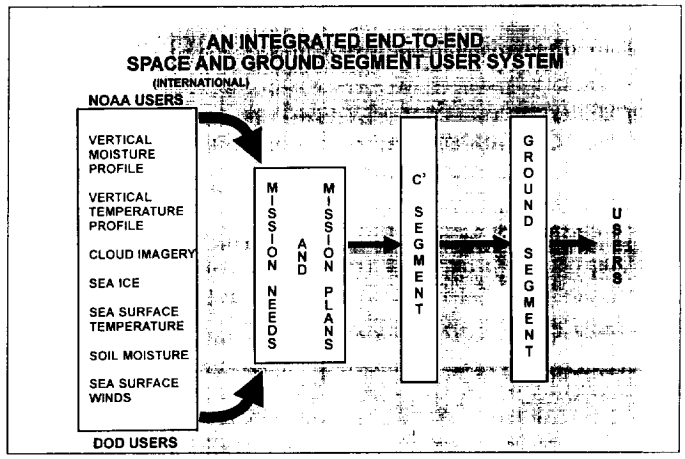

Figure RS-21

Outside that box, very importantly, is the requirements process *(Fig. RS-18)*. We will define the operational requirements, I have to underscore the word "operational." This is not a research program; this is an operational support program. Those requirements will then be given to the System Program Director for execution. The program will report to a tri-agency Executive Committee made up of Undersecretaries—the Undersecretary of Commerce for Oceans and Atmosphere, the Undersecretary of DoD for Acquisition and Technology, and the Deputy Administrator at NASA.

We have a notional architecture right now. The on-orbit constellation is defined by operational requirements with a refresh rate that requires three satellites—0530, 0930 and 1330 polar-orbital crossing times *(Fig. RS-19)*. That notional system will be made up of two U.S. satellites, and we are working with John Morgan of EUMETSAT in putting together a joint polar system (JPS). With EUMETSAT's cooperation we look forward to EUMETSAT providing and working with U.S. for the 0930 orbit, providing that satellite. This is an outgrowth of conversations that started some 10 years ago between NOAA and EUMETSAT. So there will be a joint polar system, and by the end of the year we hope to have an agreement in place.

This next viewgraph on convergence synchronization can take a half hour by itself *(Fig. RS-20)*. The point I want to make on this is really quite simple. We're going to fly out the DMSP satellites, we're going to fly out the NOAA satellites, the NOAA N and N'. METOP-1 will then be the partner to the NOAA satellite. That's where the joint polar program comes from. EUMETSAT hopefully will then fly METOP-1 in the 0930 orbit; NOAA will continue to fly N and N'. We will then work to have the first NPOESS satellite available by the year 2004 for launch. In addition, we will build into the program the option for data denial in time of war or crises so this does support a DoD mission.

Next please *(Fig. RS-21)*. This is a user-driven program. You see on your left the seven key parameters that drive this program. These are the requirements defined by both NOAA, working with our international colleagues, as well as DoD users. They'll support mission needs, mission plans. We'll have a C^3 segment and a ground segment which will then go directly to the users. These seven requirements are the

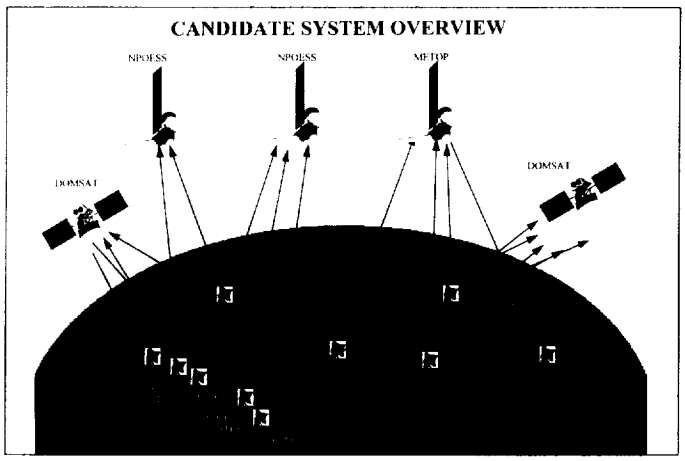

Figure RS-22

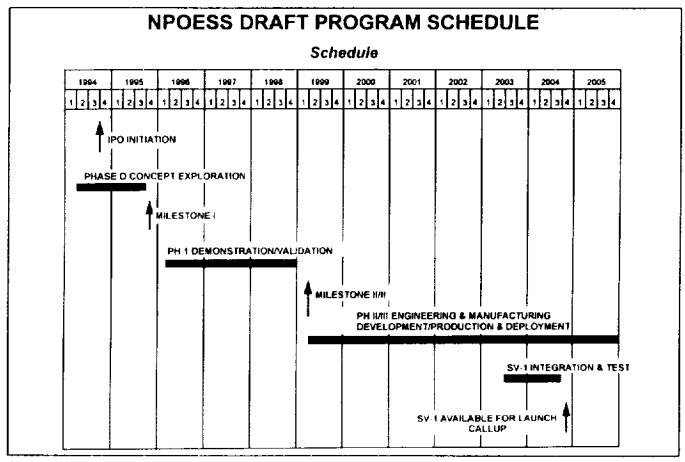

Figure RS-23

minimum requirements this satellite will support, so these are the seven requirements that we'll die for.

This next slide shows basically the overall configuration of the candidate system *(Fig. RS-22)*. Three satellites, the data coming down to a civilian community, an international community, and an operational military community. This satellite system will support a very broad community of users.

One of the things we're looking at is an early convergence of the Command and Control segment. This is motivated by DoD's decision to close its dedicated DMSP satellite operation. Right now we are evaluating how we can transition DMSP ground segment control from Air Force into NOAA. Our expectation is that in about two years we will see the operations of DMSP transitioned into NOAA, working side by side to do the ground control for DMSP. There will be a DoD backup.

I mentioned the requirements process. It's a joint agency requirements process driven by the two opera tional users, DoD and NOAA. We have defined our initial requirements. In January of this year we issued our preliminary integrated operational document. That's what the IPO is working to satisfy, and the concept studies are also working to satisfy those requirements and define the concept against those requirements. We'll then refine the requirements further as we go into the Phase I and Phase II and look at cost benefits. So it is a requirements driven process.

Our schedule is indicated on the next viewgraph *(Fig. RS-23)*. We are constantly defending to Congress why it takes 10 years to build a new satellite program, why it costs so much money, and the like. We keep trying to tell them, like the Fram commercial, "Pay me now or pay me later." If they really want to do it bad, they're going to get it bad, so we're really adhering to our 10-year development process. We feel very, very strongly about that. The first satellite available for launch is in the year 2004.

We are in the Phase 0 concept studies right now. That will be followed next year by Phase I demonstration/validation, and that will be full and open competition. We'll have two contractors participating in the Phase I demonstration.

We have defined our seven key parameters. Although we have a long list of other parameters, we're looking at all technologies to see how we can satisfy those seven key parameters. Everything we know today will be considered in the study, as well as the application of small satellite technology. My personal opinion is that I fully expect to see this as a large satellite, but we really are looking at augmentation to the program and how small sats can fit into the program. We think it's going to be a very important adjunct to what we're doing, as I believe it's an important adjunct to what we're doing in our geostationary weather satellites.

The two agencies, Defense and Commerce, have agreed to a 50-50 cost share. We arrive at that cost share by about the year 2000/2001, and the reason for that is where DoD was in its POM process and where Commerce was in its budget process. So up front, Commerce will spend a little more money, DoD a little less money; then we'll flip-flop as we get to about 1998. The point is that the agencies have agreed to this funding profile and that's what we're working toward.

An important element that I would like to add is that we're constantly asked on the Hill, why do we think this is going to work? LandSat didn't work. The reason is that we have two agencies supported by another agency with the technology. The two agencies have a vested interest in ensuring this program works. We need these data.

And finally, the next steps *(Fig. RS-24)*. Fully staff our program office. Right now we're using a staff of "loaners" until we get a program director on board. We're in the final stages of a tri-agency Memorandum of Agreement. It's going to the Secretaries of the various departments for signature. We're finalizing our agreement with John Morgan and EUMETSAT. And we're finalizing the concept studies. So this is a program that's up and operating. If you come to our building in Silver Spring, Maryland, you will see

working side by side people from three agencies committed to a program—and a lot of people thought we couldn't make it happen. Thank you.

PROFESSOR GABRYNOWICZ: Thank you. I'd like to thank the panel members for very informative presentations.

Q&A

PROFESSOR GABRYNOWICZ: The first question is for the entire panel. Remote sensing—so what?! No speaker has given any compelling reason for remote sensing. We can count global deforestation, yes, but how can that help us? What is the real tangible benefit of remote sensing? Who wants to go first?

MR. WINOKUR: I guess I'm willing to start because I've lived now in two communities. I spent most of my career working for the Navy, but now I'm in the civilian community. From my personal perspective, remote sensing is a critical ingredient for a number of activities, not the least of which is weather. I tried to explain that to a Congressman yesterday; I'm not sure he understood it or not. Clearly some of the other examples that you've seen here and work that I've done, showing that satellite systems are essential ingredients for supporting military operations, sea-surface temperature (in the old days when we had a Soviet submarine threat in certain parts of the North Atlantic we relied heavily on remote sensing to know where the Gulf Stream is), deforestation, Landsat, coastal habitat destruction, monitoring volcanos. I think you can put together a huge list of applications of satellite remote sensing.

DR. SINGHROY: I have a number of examples I can quote, but I'll give you some very brief ones. In about a week from now I'll be in Jordan, and I will be using Sar imagery to map waddis whereby they can find ground water. Water is like gold in the desert. You can find geological structures, you can drill them, and you can find water. There's a lot of money in that. If you go to any big mining conference, and if you come from a multinational, I had an imagery I didn't show, but there's an example where American and Canadian multinational mining companies are using Sar imagery integrated with LandSat thematic and spot data to find paleochannels in the Amazon, in the upper areas of Venezuela where gold and diamonds are being discovered. It's an operational exploration tool. I can give you examples where the government of Guyana has been using it for land cover, for forest inventory. Read your literature; you'll find a lot of examples there.

PROFESSOR GABRYNOWICZ: I might also direct the questioner. The Office of Technology Assessment just completed an extensive three-volume set that could be called, "Everything you wanted to know about remote sensing." I encourage you to obtain that. There are enormous amounts of information in there that will help you with that question.

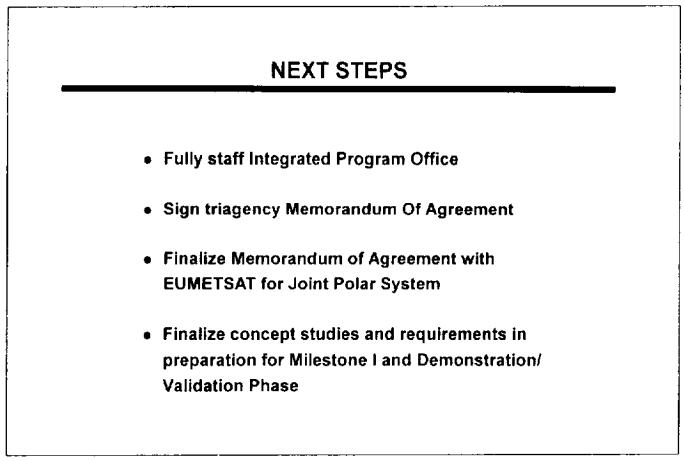

Figure RS-24

DR. FELSHER: Is there a God? I mean, I think all you need do is pick up any textbook—I mean *any* textbook, in any subject. Agronomy to Zoology, A-Z. And I think you'll find applications without any trouble at all. Perhaps it's even better understood by those in developing countries who don't have the facilities we have. I spent what I thought would be two days—it turned out to be over a week—at the UN sponsored meeting in Triesta several years ago for professors teaching geography and resources and all sorts of subjects in developing countries that barely understood the words "remote sensing" but understood the need for it. My brain was sucked dry in seven days of about, I would say, literally 15 to 16 hours a day of constant questioning. There were two Americans there, and we had to take turns breathing. I think there's no question but we can each of us construct a list of applications that covers any subject you want to talk about.

I'm not wearing my commercial hat now. That is my industrial hat. Simply as a human activity, satellite remote sensing—looking at the Earth from space and applying that knowledge—is just at the beginning. I think the applications are going to be enormous for the world.

PROFESSOR GABRYNOWICZ: I would just add one word: Perspective. You can see from there; you can see things you simply can't see from ground level, and that's what we need to know about.

The next question. Should weather data be wholly free, partially commercial, or wholly commercial? And this is for the panel.

MR. WINOKUR: From the perspective of the United States, the U.S. government's position is that weather data is free and open. That's a position that we still

maintain today. So in that context, that's the U.S. government policy up until now. It's been a longstanding U.S. policy, and because of international activities that are going on right now, the U.S. government has an Interagency Task Force that's looking at that and is making an assessment. But that assessment will take into account that longstanding U.S. policy and tradition of free and open and unrestricted access to U.S. weather data. In the international context, we'll work to maximize the international exchange of environmental data.

I firmly believe that the remote sensing will have a long-term future. Not because it can produce beautiful pictures, not because it is in the benefit of mankind, but because it has an economic benefit.

MR. MORGAN: Bob mentioned the U.S. policy, and I think what's critical to this question is that it must be in accordance to the national policy of the countries concerned. Certainly within Europe there is a different perspective. One of the things I must say is that of all the criteria of access to data, we certainly can endorse the idea in Europe also that everybody should have access to weather data. It's a value to the community and the best possible use should be made of it. But the data are valuable, and the European perspective is that as much as possible should be done to make sure the user pays for the data to make sure that there is a feedback from the user to the technology.

You didn't give me an opportunity to speak about the question, "Why remote sensing?" I firmly believe that the remote sensing will have a long-term future. Not because it can produce beautiful pictures, not because it is in the benefit of mankind, but because it has an economic benefit. And that economic benefit has to feed through from the operational users of the data right through to the data producers. And we want to produce a mechanism whereby real costs fall on real users.

PROFESSOR GABRYNOWICZ: The next question is for Murray. How will NARSIA be financed at a sufficiently high level to do a good job? How do you think that you will reach the real users of the data from Washington, especially when your thrust is legislative?

DR. FELSHER: First of all, the thrusts are not legislative. There were four thrusts mentioned in my paper and perhaps when you get to read the whole thing you'll understand it really is four. This is not a lobbying organization per se. We certainly don't expect it will take that as a major thrust. In fact, of the feedback we got from the companies that attended the meeting in January, believe it or not, the Number One was education and outreach. And I got the same feeling here this morning. To get the word out in other words. So we're not looking at this as a major thrust toward the legislature, although that is one.

In terms of financing it, this is going to be structured as a 501(c)(3). We have put together a rate schedule for companies. I can tell you what that is now if you'd care to hear it; actually, it's quite a list. But basically, for the remote sensing industry, that is, for companies in the private sector or those parts of companies dealing with the remote sensing activities, we have three scales. From less than $1 million in annual revenue, between $1 and $10 million, and over $10 million. Membership $1,000, $3,000 and $5,000. But we expect to make a major thrust into the end-user community, and we will have associate memberships from agencies and such where the annual memberships will be $100.

The questioner is absolutely correct. If we cannot get sufficient funding to do this, there will be no organization. My plea for membership is a real one. As for myself, and I point this out as I did at the Goddard Symposium when I gave a similar talk two or three weeks ago, that because of the various things I do, I will be putting this together with an Executive Committee and we will be looking for an Executive Director so I can go out and do the things I regularly do.

Is Dave Johnson here in the audience? David is with CTA, and he's one of the three members on our Executive Committee. You will see him at the CTA booth, and if you have additional questions on NARSIA for the next several days, talk to him. I serve on a Defense Science Board committee and I have to be back in Washington tomorrow, so I won't be around after this talk.

PROFESSOR GABRYNOWICZ: Have you invited academics and federal employees yet?

How will NARSIA be financed at a sufficiently high level to do a good job? How do you think that you will reach the real users of the data from Washington, especially when your thrust is legislative?

DR. FELSHER: Yes. I didn't mean to cast any aspersions on you, Joanne. You will recall that I am an ex-professor. Our initial reaction was that no, we don't want people like feds and professors, Joanne, but the argument was presented and accepted that we don't want to exclude anybody. There is a class of mem-

bership—associate membership—for the acadeems, definitely.

I mentioned Dave Johnson. Also, General Vivisek at Autometric and Nicky Trishell at ERM. The four of us are putting the thing together. The other three are the executive committee, and I'm acting as the director.

PROFESSOR GABRYNOWICZ: Again, a question for the panel. *Space News* recently reported that the remote sensing market will grow by an order of magnitude from $800 million to $8 billion by the end of the decade. Does the panel agree with this projection?

MR. WINOKUR: Let me quickly say, the numbers have been coming out from everywhere and as diverse as *Space News* or from your corner drugstore. The truth of the matter is that nobody really knows, because nobody has really defined the market. I say this as a consultant that has been paid very well to define the market. Given the choice, my own druthers would be at the higher end. But when I did the Kodak study for NOAA back in '88, we predicted $2½ billion by the end of the century, and we were told we were overly optimistic. And I think, frankly, we were overly pessimistic.

DR. SINGHROY: I think nobody really knows. The remote sensing industry should be part of the information industry; that is, I mentioned the word GIS, for U.S. to make this data very useful. Again, it's more than a pretty picture. Again, it has to be integrated with a localized system. It has to be integrated with digital terrain data. It has to be integrated with land cover information, what is known in a country. So these are some of the actual bottlenecks for that growth area. And as these two industries, the digital mapping industry and the imaging industry, move together, one creates a critical mass for the other. So, yes there is growth but one obviously depends on the other.

PROFESSOR GABRYNOWICZ: I'll add to that. I think it's going to be very important. I look at that question and I say, "What do you mean? Does that include satellite manufacture and building? Is that only the data? Is that the ground stations? Is that the programs? Are those the computers? What do you mean when you talk about remote sensing industry?" I think one of the difficulties the community has had is, we have not done enough discriminating in terms of answering that question. The two things that you hear over and over again, at least since the failed commercialization of the LandSat system in 1984, is commercialization is kind of monolithic. There's no distinction between those activities. And data is monolithic without a distinction as to what data does what for whom and why. And I think to be commercially successful, you have to make those distinctions and make your business plans based on that. It's my personal opinion that if you really want to make money, you should be going into the value added, the GIS, the ground-based applications of the data. So you need to be discriminating about that.

Actually, the next one is for me. Do you foresee the United States government withdrawing the licenses already given for commercial remote sensing to one meter resolution due to security or other reasons?

I don't know what the government's going to do any more than anybody else in this room, but I will say that the foundation for those licenses are in an active Congress. The Land Remote Sensing Policy Act of 1992 provides and gives the President the authorization to declassify hardware and software for commercial purposes. The Clinton Administration Policy is an extension of that statutory permission, and there are forces in Congress, most notably by Congressperson Bingamon, who would have that policy changed. And I would just remind people that it has a statutory foundation and the law would have to be changed as well as the policy. From a commercial point of view, that's the good news. The bad news is the law also required NASA and DoD to work together in a joint program to operate LandSat, and they decided that Act of Congress notwithstanding that was not going to be the case. So sometimes the statute is listened to and sometimes the statute is not. So that would be my answer to that question.

Dr. Singhroy, can you cite success stories where your Center's work has provided data that was used effectively?

DR. SINGHROY: I'll take the Jordan case. Ground water, managing water in deserts. We have used Sar, again to map like the veins of the desert. All the dry channels, because that's where water flowed. The interesting thing about this, they use a term called water harvesting. How you do that is basically you block your streams and your water percolates in the existing aquafiers so you have the water in there and you can tap it later on. You can use a number of remote sensing techniques, both LandSat as well as Sar imagery for that. That's one very good successful story.

There are a number of success case studies. Again, I don't want to harp on the mining business, but the whole mining technology, particularly as a result of the open up of developing countries to get new currency. They open up their resources and you have new tracks of land for mineral exploration. There are a lot of examples where multinational mining companies are using this data; it's not only for the Center's point of view.

A case in Brazil. We are looking at not only forest depletion, but also water shed mapping. A part from looking at the way you cut the forests and monitor that, is what are the erosions and so forth that are going on as related environmental. Coastal zone map-

ping, you're monitoring not only on the water side but the erosion side. Lots of examples.

PROFESSOR GABRYNOWICZ: Next question is for Bob. Is there a date when the Program Director will be named?

MR. WINOKUR: I guess the only thing I can say at this point is we have indeed made an offer to an individual. I can't name that individual at this point since there are some bureaucratic hoops that we have to jump through. I'm hoping by the end of April, for my own personal health and well-being. As part of the hoops we have to jump through, we also have to have the Executive Committee approve the individual. So I think we're within weeks.

Even if NOAA were, in some way, to be disestablished, there are clear functions that have to be continued. Some of them clearly are statutory functions so, Congress gives, Congress can take away, but somebody has to change a number of laws first.

PROFESSOR GABRYNOWICZ: Next question is for John. Did I understand there is no approved funding for the METOP series, and what is the current status of agreements, MOUs, with the United States?

MR. MORGAN: There is funding for the METOP series, but only the initial start-up studies. We have about $40 million worth of funding in hand in EUMETSAT, slightly higher than that within our partner agency, the European Space Agency, for the initial studies. And we are at the moment in the situation of seeking funds for the remaining program, that is, the construction of the satellites and their launch and operations. That by our standards is a lot of money. We're talking about 1.5 million ECUs (European Currency Units, you might not be familiar with; it's quoted in the *Wall Street Journal* so you can do the calculation). But it's pretty nearly $2 billion we need for this whole operation. We have to sign up 17 countries to that. We hope the process can be completed this year.

As far as the agreement with NOAA is concerned, we still have discussions with NOAA in progress literally today, and most of the open issues between us are solved. We are talking about an agreement which will cover the so-called Initial Joint Polar System, covering the first two satellites on each side, and we're hopeful for a signature of that before the end of this year.

PROFESSOR GABRYNOWICZ: Recent news accounts report a proposed severe cutback or even the elimination of NOAA, and dare I say I heard that news report on NPR, I suppose. Is private industry ready to take that role, and Mr. Morgan, if NOAA were eliminated, how would that affect relations between the United States and Europe?

MR. WINOKUR: I guess we hear the rumors too, but I think any announcement on the death of NOAA or the Department of Commerce certainly is premature. We were on the Hill yesterday defending our budget in front of the House Appropriations Committee, and we get to do it again tomorrow in the Senate. Certainly nobody in the budget hearing we had yesterday said NOAA was going away. They did say perhaps we had too much money in our budget and we needed to cut back. So I don't think so at this point, at least I'm not personally prepared to take seriously the demise of NOAA. Even if NOAA were, in some way, to be disestablished, there are clear functions that have to be continued. Some of them clearly are statutory functions so, Congress gives, Congress can take away, but somebody has to change a number of laws first.

I think the real issue is going to be a budgetary one, not NOAA disappearing from the horizon.

MR. MORGAN: How will it affect relations? There are two scenarios. Either the work continues with another lead agency and we would cooperate with that lead agency. If the work didn't continue, I think that's a very unlikely scenario, but even so, we would follow certainly the ideas expressed earlier this morning when we were in the vision part of the discussion, when essentially it was said, a nation's got to do what a nation's got to do. We will decide what observational data we need, and we will build satellites to suit that and we will fly them. I won't say that what happens in the United States is immaterial to what we do, we would like to have a cooperative endeavor to make it more efficient and to save costs on our side. But we're going to go ahead regardless.

MR. WINOKUR: Let me just quickly add, I think most of U.S. had at one time or other have had a little note on our board that says, "When in doubt—reorganize," and I think that there's some permanence established in one's mind to a government institution. But you have to remember that before President Nixon did his Executive Order #3 in 1970, there was no such thing as NOAA nor EPA for that matter. The functions can always continue elsewhere.

By the way, I haven't heard a single industrial component that said they would like to take over any part of NOAA ever, except for that small chunk at ComSat that wanted the MetSats back in the early '80s. But that's a whole different story, and I don't think there's any danger there.

But in terms of NOAA disappearing as an organization, they're talking about doing away with HHS, and they're talking about doing away with the Geological Survey. When I say "they," I mean the government. I don't frankly think there's anything holy about any specific agency or part of an agency. Anything can happen, quite literally.

PROFESSOR GABRYNOWICZ: One quick final question. What is the proper relationship between the public and the private sector in remote sensing?

MR. WINOKUR: Speaking in the second row, EOSAT and SPOT, hand in hand. If they can sit together, then the private sector and the government can work hand in hand. There's no question about it.

DR. FELSHER: I certainly would second that. Cooperation is essential. I think there are certain services we would view as essential government services. On the other hand, I think we have to work hand-in-glove with the private sector, the value-added part of the private sector. The private sector that provides the satellites, the ground segments, and the like. I think we really do need to work hand-in-glove and cooperation is a key part of it. Then there's also a customer relationship as well. So I think there are numerous relationships. Perhaps they'll change a little bit, but I don't think you'll see marked changes.

MR. MORGAN: I certainly agree that cooperation is needed and that, for the foreseeable future, both sectors will co-exist. They must. But there must be a clear understanding that eventually people will ask, "Why is government in this particular business? Not in the business as a whole, but in certain elements of the business?" I think it must be clear eventually that it cannot be continued where every part of the service is subsidized through taxpayers' money on a general government level. It must be, in some cases, done on a fully commercial basis where the commercial entities eventually have to pay for the satellites. Otherwise we're fooling ourselves.

We had the mention of applications. There are volumes of applications of remote sensing. They're super things—I don't want to decry that. But until the end user has to pay for the satellite as such, and doesn't get the data at rate-subsidized fees, you cannot compare it really with aircraft measurements of the same item. If you ask somebody in Jordan, "Would you prefer to have aircraft measurements or satellite measurements?" I don't suppose he would care very much where it comes from. He would ask, "What's cheapest?" And he would take the satellite data if it was subsidized and cheap. But if the full cost was put together, he would have a proper choice.

And we see that from meteorology. The meteorologists that pay for our systems really have to make a hard decision. They ask, do we want to pay for a satellite observing the total scene which is very valuable (they certainly admit that), or can we instead spend the same amount of money on a ground-based system? And that's the choice they're making, and they choose satellites because they're cost effective.

So I think in the end the users have got to recognize the full cost of the individual elements they're paying for, but it will mean many years before that happens in most cases, and the government, I think, has a duty to start the system going and to provide seed corn for the system, probably for the next couple of decades or more. But there should be a trend toward commercialization.

. . . it's useful to think of remote sensing activities like a web. Everything is connected to everything it appears. The data to the hardware, the software to the hardware, the public to the private, the user to the producer.

PROFESSOR GABRYNOWICZ: Before we thank our panelists, I'd just like to close with my remark, which is, this has been terrific. And one thing that the conversation has demonstrated is that, I think it's useful to think of remote sensing activities like a web. Everything is connected to everything it appears. The data to the hardware, the software to the hardware, the public to the private, the user to the producer. And it really invites us to do two things, and that is to have a dialogue among the different participants in the remote sensing community. To be frank, there's been severe adversarialism between users and providers, academics and government, public and private. And I think that adversarialism—I'm not talking about healthy competition, I'm talking about adversarialism—is not healthy for remote sensing activities.

And the second thing I would encourage us to do is to continue this dialogue whenever and wherever you have the chance to do so. On behalf of the panel, we'll always be glad to talk to you about that.

I'd like to thank the panel, especially John for coming all the way from Europe just for this particular thing. I asked him if he had other work that he was putting together here to make the trip worthwhile and he said, "Nope, this is why I came." So I would like to thank everybody for coming and donating their time and giving us what I believe to be a very enlightening conversation. Thank you.

MR. PAYNE: Thank you to the session speakers and to Professor Gabrynowicz for chairing such an outstanding session on remote sensing.

There Are Opportunities in Space!

Panel Moderator:
Dr. Peter Swan
Manager of Business Development
Motorola Satellite Communications Division

Speakers:
William R. Claybaugh
Business Manager
NASA Reusable Launch Vehicle Program

Ted G. Nanz
President
SPOT Image Corporation

David T. Edwards
Executive Vice President & COO
EOSAT

Dr. Francis X. Kane
President
GPS International Association

Courtney A. Stadd
Managing Partner
Global Technology Ventures, LLC

MR. PAYNE: We had an excellent morning, talking about visions, positioning ourselves for those visions, and discussing remote sensing in terms of opportunities. This next session will examine some of the other opportunities of space, and it will be chaired by Dr. Peter Swan.

There are opportunities in space. In my mind, this means there is money available for viable business projects.

Dr. Swan is leading the satellite bus team for the IRIDIUM® Communication System. He is pioneering the development of satellite and production techniques that will revolutionize the spacecraft industry and provide global communications to subscribers around the world. Dr. Swan is an internationally recognized expert in new and emerging spacecraft technology in missions and is recognized for his program management expertise.

Dr. Swan received his Ph.D. in engineering from the University of California at Los Angeles. His dissertation topic helped establish him as a leader in tether satellite designs. Dr. Swan received a master of science degree in systems management from the University of Southern California and also a master of science in nuclear engineering from the Air Force Institute of Technology. Additionally, he received a bachelor of science in engineering from the United States Military Academy.

Please welcome the moderator of our session on opportunities in space, Dr. Peter Swan.

DR. SWAN: Thank you, Dave. I'm really excited to be here today because the topic of the Symposium—which is Vision and Reality—and the topic of this session are timely for my business as well as for me personally—the timing is just about right for my personal career.

Vision and Reality—that's exactly where we are in IRIDIUM®. We have come up with a vision that is to provide a cellular-like phone any place, any time, for anyone. It is a total vision that encompasses the globe. The reality is that we're within 500 days of launch. Everyone in this room knows what that means. The schedule is starting to become paramount.

I was over at the exhibits next door and picked up *Aviation Week,* and it's timely in terms of IRIDIUM®. It has an article entitled "Iridium on Track for First Launch in '96" and a sidebar entitled "New Technologies Allow 22-day Satellite Assembly." In fact, the IRIDIUM® team is changing the way space is conducted. Instead of 18 to 36 months of assembly and testing, we're going to do it in less than 22 days.

This is the vision: Any place, any time. The reality is: Launch is coming up fast.

But first, let's talk about the panel. There are opportunities in space. In my mind, this means there is money available for viable business projects. The technological advances over the last 40 years have encouraged investment in this arena of commercial space businesses. Each panelist is here to discuss some aspect of that topic. Just recently, I was reading an article by Theresa Foley entitled "Satellite Financing or How to Raise Funds for a Risky Business." It still is risky. Rockets still blow up. We hopefully are going to put up 100 satellites, and that means there are going to be a lot of opportunities.

Going through that article, I noticed that there was a list of financing over the last few years. Just a few of these are $440 million in '92 for PanAmSat, $335 million in '94 for EchoStar, $1.6 billion in '93-94 for IRIDIUM®, $1.4 billion in '94 for InMarSat-P, $180 million in '94 for Odessy, $294 million in equity funding for Global Star, $200 million in public offering for

Global Star, $157 million over a period of time in public funding for Orbital Sciences Corporation. The money is there; thus, the opportunities are there.

While there's no up and down in space, the ups and downs of the business world drive the opportunities for space ventures. Let me just show you one approach in financing *(Fig. OS-1)*.

This shows the flags and the titles for all the investors for the $1.6 billion for IRIDIUM®. It's a consortium that was formed, then provided $800 million in July '93 and another $800 million in September '94. The next chart shows the global reach of the telecommunications companies around the world that invested in this business. The real key is that the opportunities are there, and there are many of us pursuing them. The excitement is growing, and the financing is becoming real. Now we have to face reality.

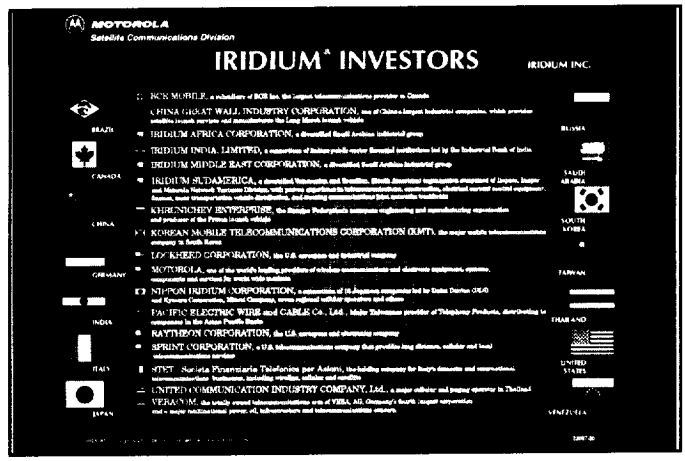

Figure OS-1

This distinguished panel has a cross-disciplinary texture to it with expertise in launch vehicles, communication systems, navigation, earth resources, and some expertise on the Washington scene and entrepreneurial financing. I will introduce each panel member. He will then present his talk. We will hold the questions until the end. We'll have a good 20 to 30 minutes of questions at the end of the period.

The first speaker is Bill Claybaugh. He is the business manager for NASA's reusable launch vehicle program. He is responsible for the development of government-industry business arrangements focused on improving the economics of the space transportation industry. He recently was a special assistant for commercial programs to the associate administrator for Advanced Concepts and Technology, where he was involved intimately with the X-34 program. Mr. Claybaugh holds dual degrees from California State University Dominguez Hills in history and Asian studies and a master's in management from Yale University. Let us welcome Mr. Claybaugh.

MR. CLAYBAUGH: Thank you, Peter. Jack Mansfield offers his apologies. He did want to make it here today. As I gather you know from France Córdova's talk last night, everyone was on the Hill this morning. Jack will be coming in tomorrow.

This presentation was originally called "Bull-ish about Space," but I kept mispronouncing it.

We're going to look at three general areas. Those broadly breaking into effects from space, things that are in space, and getting to space.

My colleagues in the remote sensing and space communications division offered me this slide *(slides not available)*. As a former venture capitalist, I have a couple of comments, most notably with factor of 10 increases in market projections. Either this is a remarkable business opportunity, or they've gotten hold of some of that stuff that the senior managers at NASA use all the time. In any case, I would particularly like to note the hyperspectral business where there is, in my judgment and in the judgment of my colleagues, a tremendous opportunity to build very small spacecraft that can image across essentially the entire visible and infrared spectrum, allowing users to choose the band or bands that they wish to downlink.

The communications industry speaks for itself. Peter's list of investment to date is certainly indicative of the kind of expansion that is likely to occur in that industry over the next few years.

The Space Processing Division has, for a decade and some change now, been looking at trying to figure out how to take advantage of the unique properties of the space environment other than the altitude. In that regard, it has done a lot of work, sponsored a lot of industrial work, and sponsored a lot of joint work with industry on manufacturing in low gravity. Probably the most germane thing that we can say about that is after a decade and a half of offering space travel for free, because the defacto price of space travel for research and materials processing is zero, we have—as a friend of mine calls it—bupkus so far, which probably reflects the fact that it's a hard problem.

I would like you to all think a little more about another opportunity—that is, making use of the high vacuum in space. Because of leakage of hydrogen through chamber walls, there is a fundamental limit to the level of vacuum that can be reached on the Earth's surface. The Wake Shield facility can do two orders of magnitude better than that level. And again, recognizing the fact that sponsored research with NASA involves paying nothing for the cost of space travel, there are, one would suspect, tremendous opportunities that may, *may*, come out of the Wake Shield facility.

I want to talk a little about an area that I suspect everyone in this room has finally recognized is the core problem. It's the price of space travel. This chart is a map, if you will, of the price elasticity for space transportation. It was developed by the Commercial Space Transportation Study team, a joint NASA-industry group that surveyed across the board and is, I believe, widely regarded as the best effort to date to understand the effects of price cuts on demand for space travel.

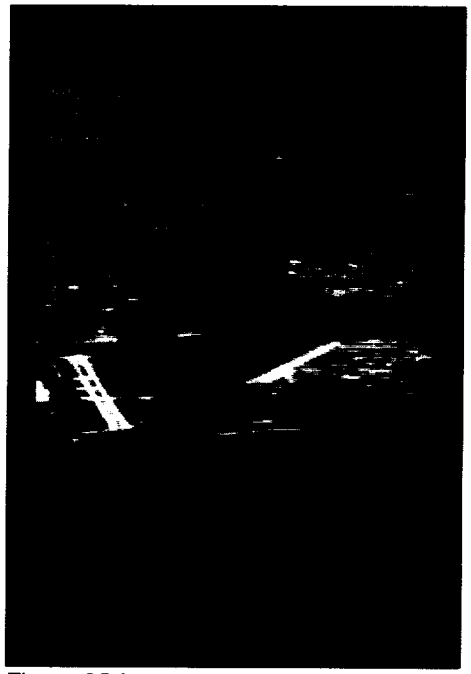

Figure OS-2

You will note three curves. The bottom-most curve, the most conservative one, assumes that under ever-decreasing prices—as you can see it goes all the way down to $100 per pound placed in earth orbit—nothing changes. All that happens is we keep doing exactly the same businesses that we are doing today. As you can see, those businesses grow some.

The high curve assumes that everything that anyone could ever conceive of gets done. The middle curve, which is the one I want to focus on, is a curve that was put together using the judgment of the team members—and I want to emphasize this was a very large group of people representing all the major aerospace companies. The consensus developed was that there were at least two opportunities under decreasing price that made economic sense.

That bottom curve shows, as you will note at around $600-700 a pound, a break in the curve. That opportunity—and I will ask that we reserve the giggle factor on this one—that opportunity is the business of disposing of nuclear waste. It turns out, after a thorough economic analysis, that everyone makes money at around $600-700 a pound getting rid of the 4 percent of waste after processing which needs to be permanently disposed of. The utilities make money, the processors make money, the transportation company makes money, the people who are in the business of placing it in solar orbit or on the far side of the moon make money. That is the first major new market opportunity identified by this study. Setting aside the political issues, it looks like a way to make money *if* the cost of space travel drops below $600 a pound. You will note that the curve then continues to go up in an approximately exponential fashion.

The delta above the straight line in that curve is the beginning of space tourism which, on the basis of this study, it was concluded would start at around $400 a pound and become a very major industry at around $100 a pound. Please note the tonnages on the Y-axis on that graph. We are talking about levels of usage of space that are orders of magnitude greater than what we are doing today.

This is what we're doing about that problem. These are a series of concepts, whose vehicle designs are changing very rapidly. The first is a Rockwell concept for a reusable launch vehicle.

The next one is the current McDonnell Douglas design, then a somewhat earlier version of the Lockheed design. And finally, the X-34 in its current design. I want to emphasize that all of these vehicles are changing very rapidly and that they are X-vehicles. We are not building at this time low-cost space transportation systems. We are building systems to prove the technology to allow us to build low-cost space transportation systems at some point in the future. Those systems are the X-34 and, hopefully in a couple of years, the X-33. Thank you.

We are not building at this time low-cost space transportation systems. We are building systems to prove the technology to allow us to build low-cost space transportation systems at some point in the future.

DR. SWAN: Thank you, Bill. Our next speaker is Ted Nanz, who is the president of SPOT Image Corporation. He became the president in 1990. Prior to joining SPOT Image, Mr. Nanz served as president of DynaTech Communications, a data communications company; president and CEO of Coherent Communications Systems, in networking. He has a lot of experience in this area and also has been with Motorola for 10 years.

He has a bachelor of science in electrical engineering from the U.S. Naval Academy, but luckily we have two West Pointers on the panel to counter that. He has a master of business administration from Florida Atlantic University, Boca Raton, Florida, and he's a certified quality engineer. Let's welcome Mr. Nanz.

MR. NANZ: Had they told me I'd be surrounded by two West Point guys, I would have had second thoughts. But I'm here, and it's good to be here.

Vision and Reality: Face to Face. What is the *Vision*? The vision comes from the answer to people who ask me who our customers and potential customers are. The answer is anybody in the world who has

Your name is:	The date is:	You are at:	You'll recognize this as:	Wouldn't you like to have had:
Confederate General George Pickett	3 July 1863	Cemetery Ridge	The Battle of Gettysburg	3 dimensional satellite imagery of the terrain and the enemy forces
Fast forward almost 100 years:				
Japanese Fleet Admiral Yamamoto	4 June 1942	Midway	Battle that turned the tide in the Pacific	Wide area synoptic satellite imagery of the location of both forces' aircraft carriers
Move forward a little bit. A few months ago we celebrated the 50th anniversary of the Battle of the Bulge:				
American General McAuliffe	16 Dec. 1944	Ardennes Forest	Battle of the Bulge	Satellite imagery of the Nazi forces moving on last attack with World War II
Move forward a little bit more:				
American General Douglas McArthur	26 Nov. 1950	Your forces are at the Yalu River	Entrance of the Chinese Communists into the Korean War	Satellite imagery showing the Chinese Communists massing north of the river
Fast forward. It is now the late 1990s — this decade:				
A CINC	Late 1990s	Any place where you least expect it	Next major war	Wide area synoptic coverage of the battlefield like General Schwartzkopf had for Desert Storm and Desert Shield

Figure OS-3

an interest in what is happening on the surface of the earth or in the atmosphere above it!

What is the *Reality*? The reality is that this is hard, hard work. There are Opportunities in Space! What are the Forecasts? Space forecasts? Spacey Forecasts? Spaced-Out Forecasts?!!

It is a pleasure to see so many professional colleagues and personal friends at this symposium. I realize that the audience here is quite mixed among military, government, and commercial. So I'm going to start with the early users, the military, move on to remote sensing, GIS, and the industry that we're all about. the government, and wind up with the commercial users who, in my opinion, are the people who are going to make or break remote sensing, GIS, and the industry that we're all about.

This first slide is a three-dimensional SPOT image of Colorado Springs. I have brought with me prints of this image that I will make available to anybody who would like one at the end of this panel *(Fig. OS-2)*. It's kind of interesting to see the airport in the foreground, the mountain range in the background, and the city in the middle depicted by the blue/grey characteristics. As most of you know, the satellite sees vegetation red rather than green, so going up into the mountains and to Pike's Peak in the background, you will note the red from the vegetation on the hills.

So, what is the first question the President or the Commander asks? During the Cold War it was "Where are the carriers?" During the '90s it is "What imagery do we have? What information do we have?" I will be discussing aspects of satellite remote sensing with you this afternoon, but first I would like you to participate with me in taking a brief journey through history *(Fig. OS-3)*.

Now back to the issue of the symposium—"Vision & Reality: Face to Face." In a recent issue of *Space-Watch,* a corporate executive was quoted as saying,

Figure OS-4

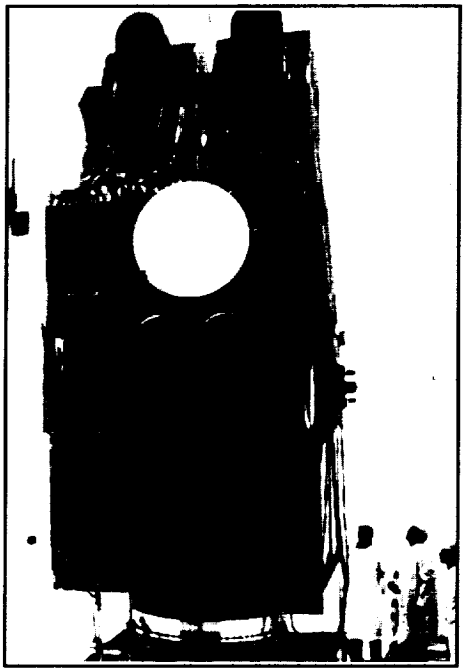

Figure OS-5

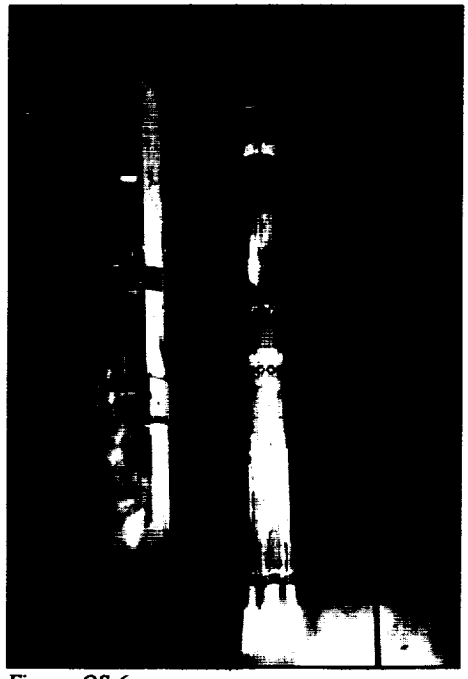

Figure OS-6

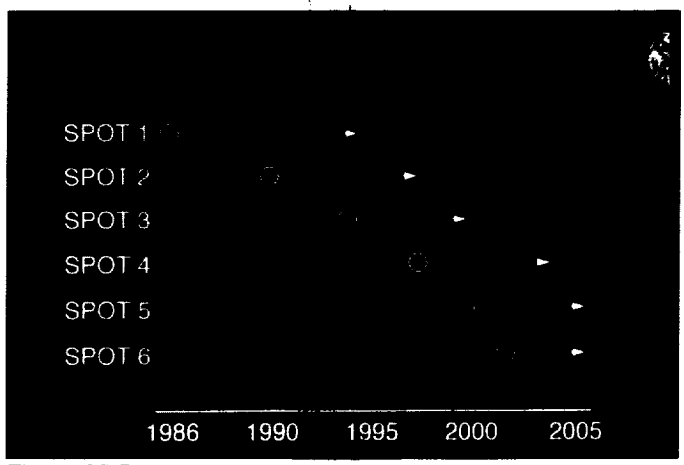

Figure OS-7

"Build it and they will come." I couldn't disagree more. I am here to tell you that even with great vision, the reality is hard, hard work. Great riches are not automatic.

This slide shows medieval armies going to war with swords, bows, and arrows *(Fig. OS-4)*. Behind the commander's tent is a salesman attempting to sell a machine gun. The commander is saying, "No, I don't have time to talk with some crazy salesman, we have a battle to fight." This is obviously a light touch cartoon; however, it says volumes about the impediments, hurdles, and difficulties that this industry—satellite remote sensing—has and maybe some of the other space imagery has in growing markets—not only in the obvious military and environmental applications, but also in emerging commercial applications.

I flew to Colorado Springs on Monday night after having attended a major commercial symposium in Chicago entitled "Business Geographics." While our industry's vision is great, the reality is that few people know about information from space and even fewer have yet embodied its use. It is apparent to me that what we in this industry need to do can be stated by paraphrasing a United States President: "Ask not what space can do for you, rather ask what you can do for space." Too many times I hear people say, if the government would do that, or if industry would do that, or if somebody else would do whatever. Again, "Ask not what space can do for you, ask what you can do for space."

This slide is a photo of a SPOT satellite *(Fig. OS-5)*. With workmen alongside it, it helps you appreciate the size of one of these satellites.

This slide is of the night launch of SPOT 3 in September 1993 *(Fig. OS-6)*. It's interesting to note that while our product is spatial information, the tech-

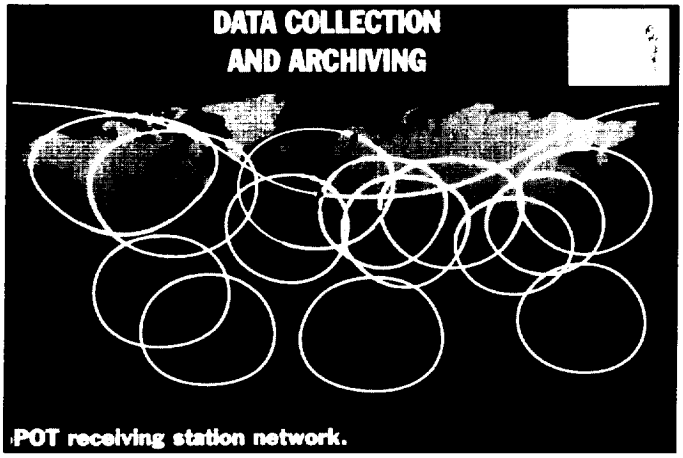

Figure OS-8

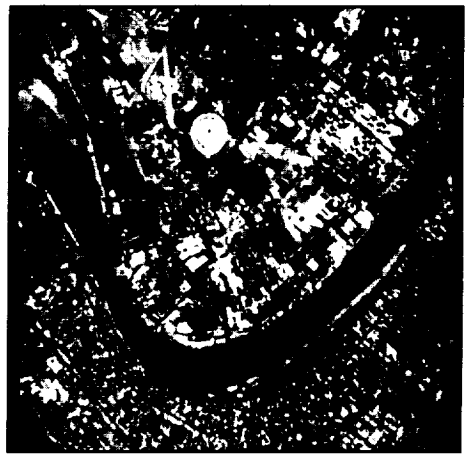

Figure OS-10

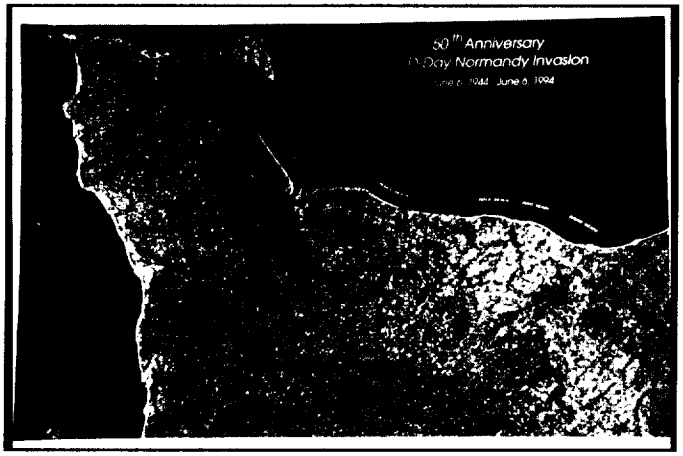

Figure OS-9

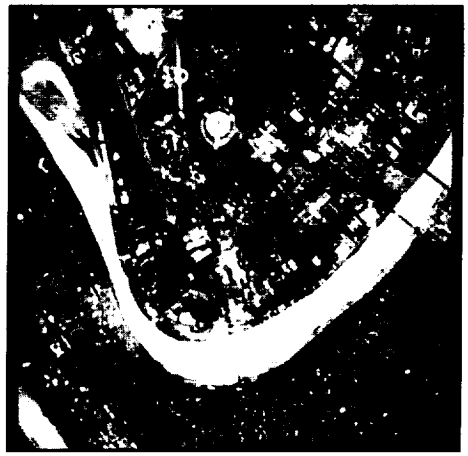

Figure OS-11

nology to get it not only includes the sensors on the satellite, but also the designing and building of the satellite, as well as its launch and the satellite communications involved, both in uploading programming and downloading information.

Continuity is a big question in the industry. Some of the overheads this morning showed tentative plans, yet-to-be budgeted satellites. This is a real brief overhead showing SPOT 1, 2, 3, 4, and 6 into the next decade, century, and millennium *(Fig. OS-7)*.

This slide conveys worldwide receiving stations, so that you can appreciate that the satellite imagery can be downloaded from the satellite almost any place in the world, as well as being stored on recorders *(Fig. OS-8)*. At lunch today we heard a gentleman saying that he's only using one receiving station to get all of the satellite data. That may be right, or it may not be right, for that company; I'm not in any position to say. But I've got to tell you that based on my experience, having a network of receiving stations circling the globe like this is very, very valuable, and I wouldn't give this up for all the tea in China.

This slide is of Normandy (Wouldn't General Eisenhower have liked to have had something like this!) *(Fig-OS-9)*

These next two slides are among my favorites. This first one is of Baghdad with bridges, and this second one is Baghdad without bridges *(Fig.OS-10-11)*.

For several years we have been selling Russian synthetic aperture and high resolution satellite imagery, and there's a big international implication to this business that we've only heard a little bit about so far during this symposium *(Fig. OS-12)*. This slide is an interesting shot of the Kremlin taken in December 1991 during negotiations with the then Soviets, depicting the only time in history that two different flags simultaneously flew over the Kremlin—the Soviet hammer and sickle on the right and the Russian horizontal white, blue, and red on the left.

This slide depicts some of the reality in achieving the vision *(Fig. OS-13)*. It talks about making things valuable. The left column shows carbon being made into diamonds, then into jewelry. Carbon has little value, diamonds have some value, but jewelry has a lot of value. The second column shows silicon being made into semiconductor wafers, then into integrated circuits. Integrated circuits, as you will appreciate, have great value; sand has very little. The third column addresses our challenges, turning raw satellite

Figure OS-12

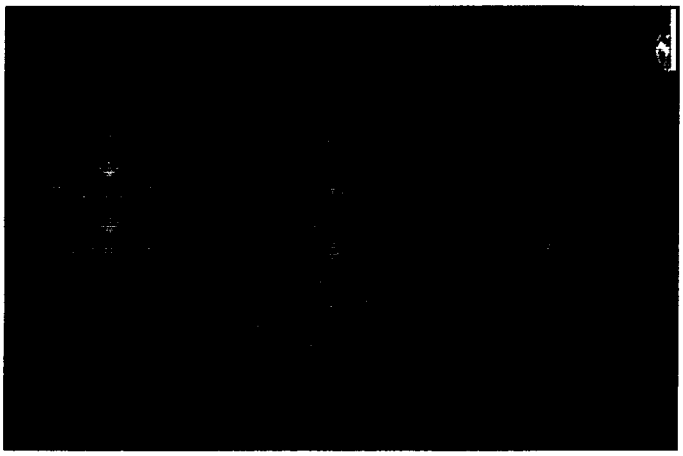

Figure OS-13

data into processed imagery, then into attributed spatial information. The raw data has little value to most users; spatial information has great value. One of industries' challenges is to develop products that better correspond with the final element in each of these three progressions.

Several articles in recent publications, including *Space News,* talk about convergence of technologies to propel market growth. During the slide of the rocket launch of SPOT 3, I talked about satellite communications technology for uploading programming and downloading information. More and more related products and services depend upon the inclusion of GPS technology, as well as ground processing and distribution. Another analogy has to do with the development of the personal computer industry in the 1980s. This development came on the heels of the convergence of many things—specifically hardware, software, and distribution.

This slide is for my GPS friends *(Fig. OS-14).* It shows a large ship going aground in the harbor with people on the pier stating, "He said he was using the global positioning system to navigate the channel when the DoD turned on the selective availability degrader!"

Figure OS-14

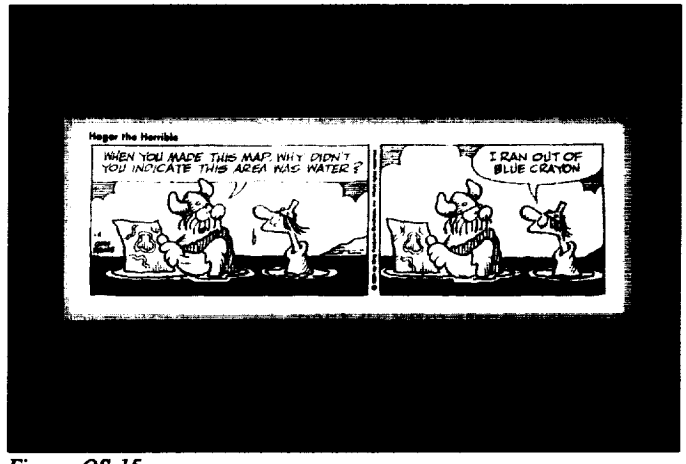

Figure OS-15

Showing that we can poke fun at ourselves, the next slide is of the cartoon character Hagar. It shows Hagar and his friend knee deep in water holding maps, and Hagar stating, "When you made this map, why didn't you indicate this area was water?" "I ran out of blue crayons!" was the answer *(Fig. OS-15).* This gets back to my slide a moment ago about the fact that raw data is of very little use to people, and that special information is of great use.

An exciting new development is an Air Force project called Eagle Vision, as depicted in the next slide, which is a transportable satellite imagery receiving station now located at USAF European headquarters at Ramstein Air Base. It can be transported any place in the world and set up to receive imagery within 24 hours *(Fig. OS-16).* Much credit to this goes to Air Force Lt. Col. "Snake" Clark. This was developed after the Gulf War, based on the need to send

Figure OS-16

Figure OS-17

"imagery to the shooter" much faster. For anybody who is interested in the tremendously successful usage of satellite imagery during Desert Storm, I recommend you read an "after action" report authored by Air Force Captain—now Major—Jim Jeffries, an F-111 pilot who was instrumental in getting satellite imagery to the coalition forces and who is now stationed at the new Central Imagery Office in Washington D.C. The United States Air Force plans to showcase Eagle Vision at this year's Paris Air Show.

In conclusion, I was asked the other day what SPOT stands for. The secret is out, as depicted in this final slide! *(Fig. OS-17)* Ladies and gentleman thank you very much for your attention.

DR. SWAN: Our next speaker is David Edwards. He's the executive vice president and chief operating officer of Earth Observation Satellite Company. He's responsible for all of EOSAT's domestic and international operations including marketing, satellite mission management and follow-on satellite development. He has 19 years of experience in the aerospace industry, including 10 years with Hughes Aircraft. Before joining EOSAT, Mr. Edwards served since January 1990 as director of financial planning in Decision Support System at the Hughes Aircraft Corporation headquarters in Los Angeles.

He has earned both a bachelor of arts and master of science degree in finance and accounting from Adelphi University in Garden City, New York. Mr. Edwards academic background includes coursework in oceanography at the Florida Institute of Technology.

Let's welcome Mr. Edwards.

MR. EDWARDS: Thank you. The Symposium is about going beyond the vision, so I would like to share with you about how we see that.

When I began thinking about what I should say to start my talk, a quotation from W. Clement Stone came to mind: "What the mind of man can conceive and believe, it can also achieve." This quotation makes a lot of sense in light of the Symposium's theme, because a lot of the technologies that we are talking about are always pushing beyond the horizon. And remote sensing is one of these.

The Successful Satellite-Related Technologies

Just to recap a little bit. There has been significant success in satellite communications. Steve Dorfman talked about that earlier today. A lot of people have talked about navigational systems and GPS. Earth observation will be the next successful commercialization of space technology, with partnerships between governments and the private sector. I find the significant thread that links these three technologies to be interesting. In satellite communications, GPS, and Earth observation, people in the general public understand the technology and why they need it.

In communications people are always looking for an easier way to access somebody else so they can communicate, talk, and exchange information. Navigation—GPS—responds to people's desires to know where they are or, at least, to their hope of finding their way out from where they are. Earth observation addresses people's needs to know what it is going to take for them to manage Earth resources in a very practical way.

Remote sensing is now poised to follow the other satellite-based applications along the trajectory of international alliances, private-sector initiatives, and public-private partnerships. And the current focus on operational users will lead to geometric growth in the industry *(Fig. OS-18)*.

International Partnerships

We in the United States can be justifiably proud of what we achieved with the U.S. Landsat program. Remote sensing, however, is as much an information industry as it is a space industry. And in the Information Age, the need for accurate information and knowledge will make the nationality of Earth observing systems a secondary issue compared to the utility of the information provided. In fact, users who limit

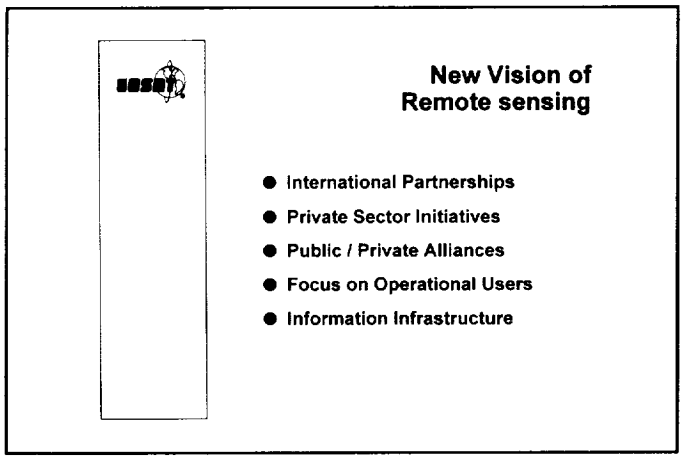

Figure OS-18

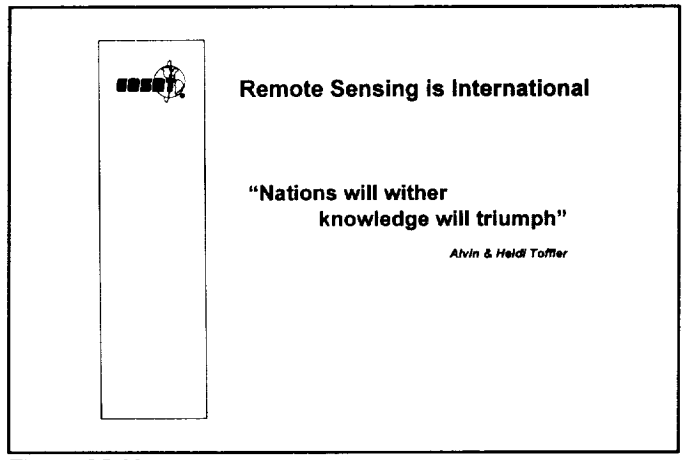

Figure OS-19

themselves to data produced by satellites from their own countries' domestic systems really risk cutting themselves off from important information resources *(Fig. OS-19)*.

The bottom line is that Earth observation is inherently international because knowledge is international. This does not mean that we will not continue to see national systems like Landsat, SPOT, and the Indian Remote Sensing (IRS) satellites. But it does mean that international partnerships and alliances that make data from a multitude of systems easily available for users worldwide are essential for the full potential of the remote-sensing industry to be met.

Private-Sector Initiatives and Public/Private Alliances

Let me talk about some of EOSAT's alliances. One is with Antrix, the commercial arm of the Indian Space Research Organization, ISRO. Under our agreement with Antrix, EOSAT is the exclusive, worldwide marketer of data from the eight-satellite constellation to be launched by India over the next 10 years. Two of these satellites are already flying today. In October of this year, a third satellite will be launched, IRS-1C, which has a combination of panchromatic data with spatial resolution between eight and 10 meters and four multispectral bands. In 1997, a duplicate satellite, IRS-1D, will be launched. By ensuring that the same data sets will remain available in future years, IRS-1D addresses the issues of continuity raised by Ted Nanz. IRS-1C and 1D will also include a Wide Field Sensor (WiFS) with a 774-kilometer swath. The WiFS instrument will be particularly useful in ocean sensing.

These are the two systems we have coming along in the near term, and they will be followed by four others. We will being doing a few studies to help our partners in India decide what instruments should fly on these later satellites.

We have also become a distributor for Japan's RESTEC, which holds the rights to JERS data. As we have found out since we started selling JERS data last October, there are a lot of clients we have not been able to support with data from Landsat because of cloud cover. The radar sensor on JERS sees through the clouds and thus produces cloud-free data. We have been satisfying quite a few clients: since October, EOSAT has become the single largest distributor of JERS data.

EOSAT has also entered into alliances with the European Space Agency (ESA). We have an agreement with ESA to start receiving ERS-1 data at our Norman, Oklahoma ground station, and then to leverage that into ERS-2 once that satellite is launched. Actual distribution rights to ERS-1 data are held by an international consortium, and we have signed a parallel agreement with one of the consortium members, RADARSAT International, which allows us to distribute ERS-1 data.

Our ground station in Norman, Oklahoma, illustrates how the private sector and public sector can work together to expand the availability of remote sensed data for the growing market *(Fig.OS-20)*. The station is commercially operated, but it receives data from the U.S. Government's Landsat system, ESA's ERS-1, and India's IRS-1B and IRS-P2.

EOSAT has a partnership with Telespazio called Teleos. This is a commercial version of the U.S. Air Force's Eagle Vision, which Ted talked about. We have put a portable ground station in Nairobi. We went into Kenya because, as you heard from earlier panels, one of the biggest problems in developing countries is the data deficiency resulting from a lack of infrastructure. Deploying a portable ground station in data-deficient areas of the world gives us an opportunity to build the infrastructure, beginning with the ground station itself, and then add the training and education needed to build the market. As the infrastructure develops, a more permanent ground station can be built, and we can take this portable one and go to another data-deficient area *(Fig. OS-21)*.

We also have a partnership with PADCO and Kibirso to bring Russian high-resolution satellite data to the market. PADCO is an American company; Kibirso is a Russian GIS company.

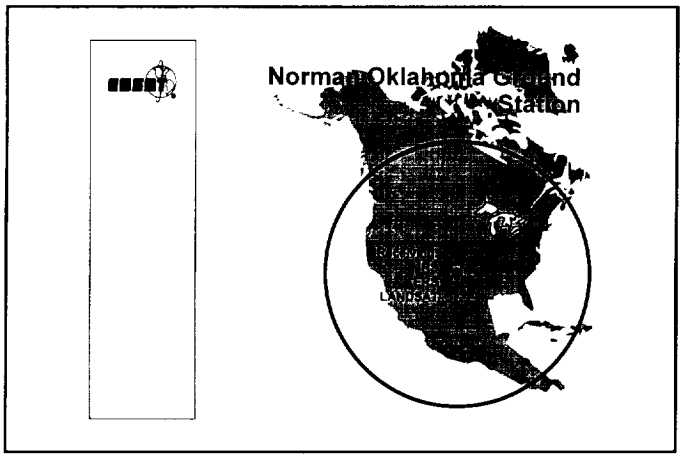

Figure OS-20

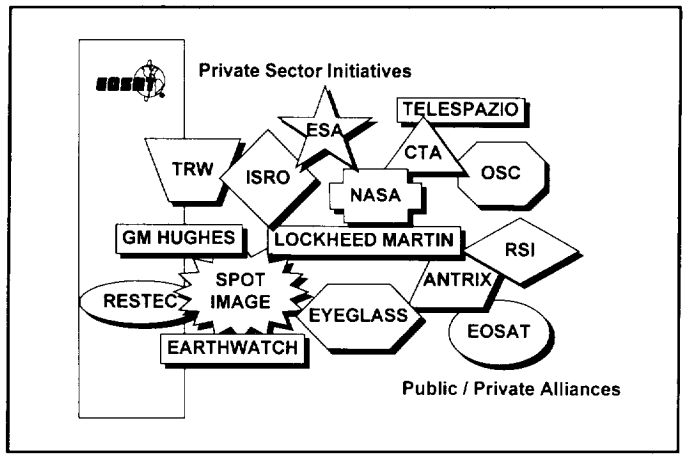

Figure OS-22

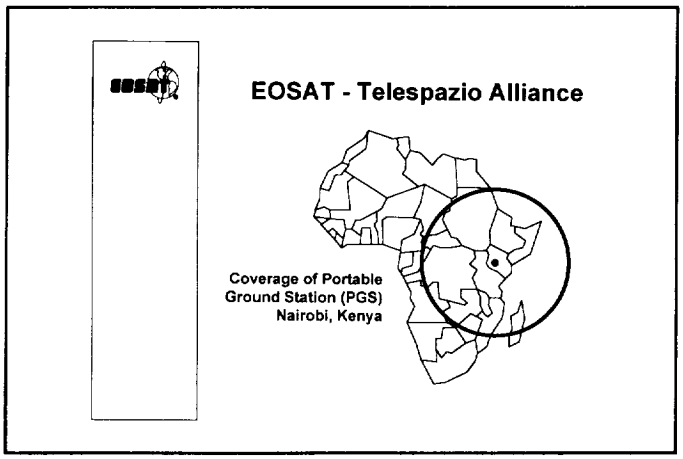

Figure OS-21

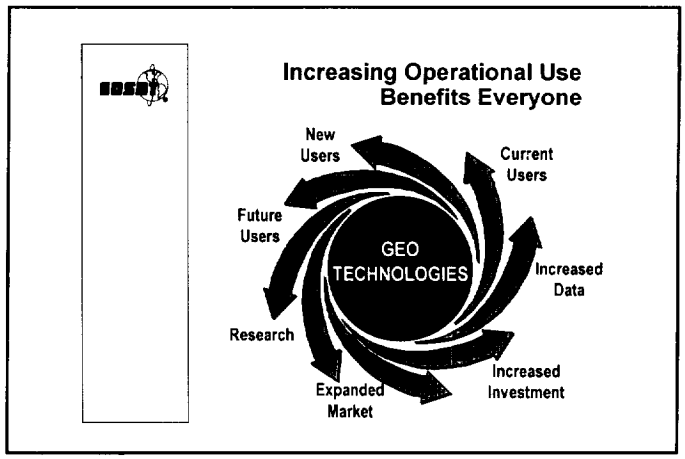

Figure OS-23

This slide gives you some sense of the expansion associated with the significant amount of investment coming in from private industry as well as from public-private alliances *(Fig. OS-22)*. Most of the companies and organizations shown on this slide are represented here today. And this is not a complete list, but it gives a fantastic demonstration that this is an ever-growing industry.

These are the kinds of partnerships and alliances that the remote-sensing industry needs to encourage.

Operational Users Drive the Market

What is driving the remote-sensing market? Operational users. To address the needs of operational users, the industry is focusing on making the data easier to get and easier to use. For EOSAT, the focus on the operational user includes expanding our product line to offer formats and media that are easier to work with. We have joined forces with software and value-added companies to create products tailored to specific market segments. We are expanding the selection of data sets we sell so that data users only need to make one phone call to find the remotely sensed data they need.

Let me stress that the focus on operational users does not mean that scientific research is neglected. As the base of operational users grows—and data sources are added to serve them—researchers will have more data from which to choose. Continuing research, of course, improves the effectiveness of the operational use of the data. Thus, both researchers and operational users benefit *(Fig. OS-23)*.

An Information Infrastructure for Remote Sensing

If we look at how everybody is benefiting from this, we can see that the international alliances, private-sector initiatives, public-private partnerships, in what can be called an "Information Infrastructure." and the focus on the operational users come together *(Fig. OS-24)* From the standpoint of the whole industry, what is key is not the ground segment, or the handshakes on the international partnerships—it is the users. The revenue that is going to drive the growth in this industry comes from them. Worrying about a hardware competition between one instrument supplier and another, one satellite supplier and another is not really going to make a difference in this industry. What makes a difference is how we get users their data and satisfy their information needs.

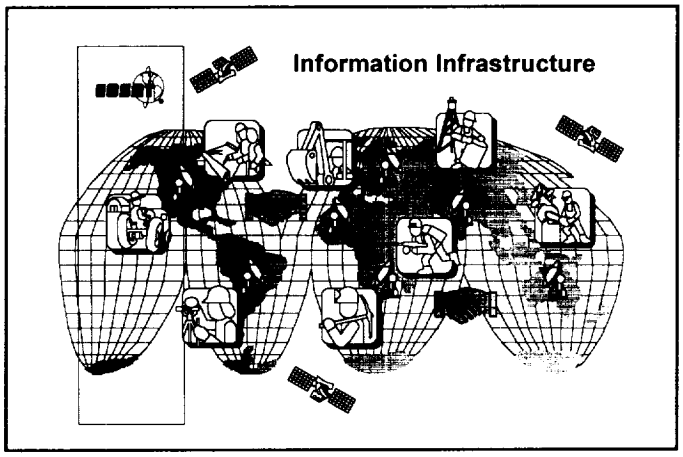

Figure OS-24

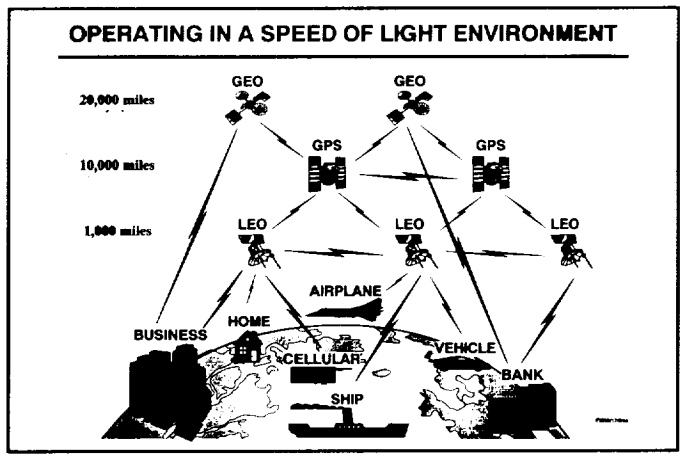

Figure OS-26

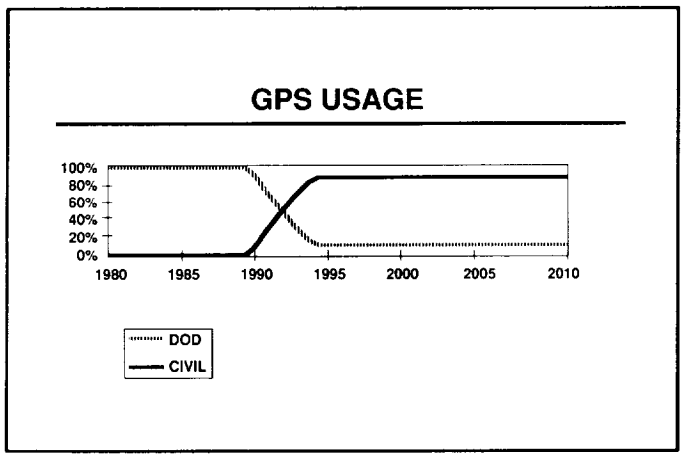

Figure OS-25

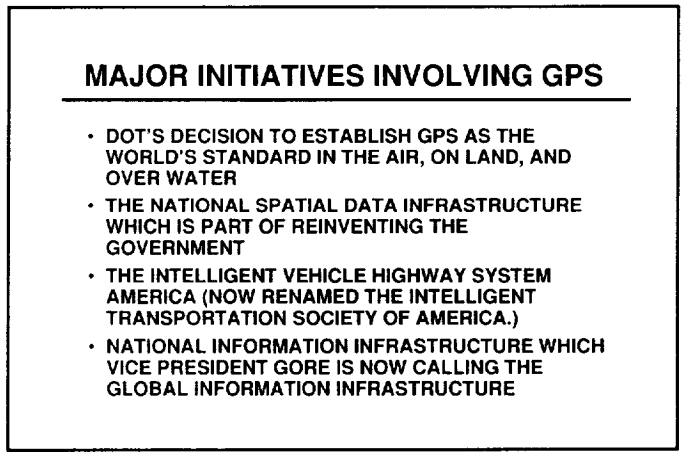

Figure OS-27

Conclusion

What we are trying to do with a wider selection of data and our international alliances is to build this information infrastructure. So, in short, by building an information infrastructure, EOSAT is helping to create a new reality today. Thank you.

DR. SWAN: Thank you, David. Our next speaker is Dr. Kane. He is the president of the GPS International Association, and I understand he has a very busy day scheduled for Friday. In addition, he has been a consultant over the last few years. He was the director of Strategic Systems, Advanced Systems Development, Rockwell International at the corporate offices from August 1981 to 1986. Prior to 1981 he held many critical positions in industry and government, many dealing with space. He graduated from West Point in January 1943. He received an M.A. from Georgetown University in 1949. He received a Ph.D. from Georgetown University in June 1960. His dissertation topic was on "Principles of Planning the Influence of Science and Philosophy," and I think over time those skills are becoming more and more important. So let's welcome Dr. Kane.

DR. KANE: Thank you for the introduction, and sincere thanks to General Hill and Dick MacLeod for inviting our GPS International Association to co-sponsor the 11th Space Foundation's outstanding space symposium, especially the sponsorship of GIA's first annual meeting Friday morning. We are privileged to participate.

As you know, GPS started as a military program, but now the civil users have awakened to what the services have learned over the past years, namely, that the use of GPS increases productivity, contributes to safety, and is important to security *(Fig. OS-25)*.

Visions of Commercial Opportunities

In my discussion I plan to focus on the civil users of the GPS community and how they benefit from the same attributes—producing safety and security. First, I would like to make some global observations.

Some Global Observations

The Space Age is now some 40 years old and most people have spent their entire lives in the Space Age. And we have been living in a rain of electrons and photons, soon to become a torrent. I call it "Living in a Speed-of-Light Environment" *(Fig. OS-26)*. GPS is

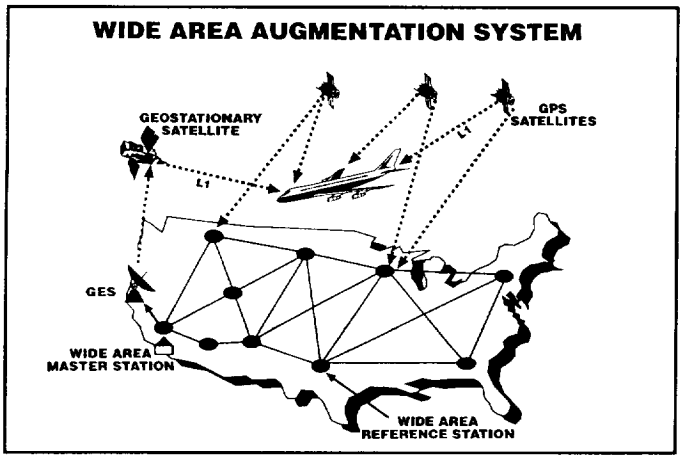

Figure OS-28

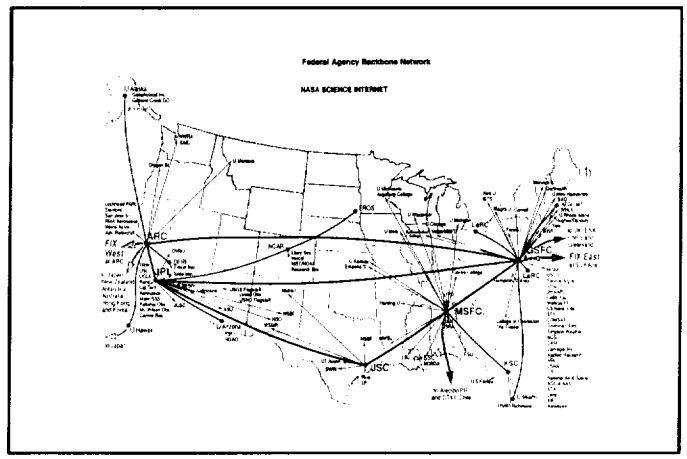

Figure OS-29

unique among the space systems because it is the only one in which we, the users, can interact with it. If we have problems with signal reception and we want to know whether it is our equipment or the satellites that are the source of our difficulties, we can call the Coast Guard Navigation Center in Alexandria, VA and ask why our display shows that SV13 is not performing. Or we can call Colonel Pete Worden, Commander of the 50th Space Wing here in Colorado Springs or his 2nd Space Operations Squadron to learn why our GDOP is so poor.

Classes and Types of Users

There are four major on-going initiatives involving GPS and impacting on nearly all of us users *(Fig. OS-27)*.

Those of you who are familiar with our inaugural newsletter have seen the list of 123 types of users compiled by George Wiggers of the POS/NAV office of DOT Policy and Will Johnson, the GIA Executive Director. I have a different version, one with broad classes of users.

First are static users, the surveyors. They were among the first to grasp the importance of GPS for position location because it enhances productivity. One surveyor can do in one day as much as five in a week.

Second are the mappers. They have literally inherited the Earth. GPS has made all pre-GPS maps ob solete. We're doing this whole thing all over again. Imagine mapping Russia to GPS accuracy.

These two classes are highly specialized and use special receivers—12 to 24 channels. The National Oceanic and Atmospheric Administration has proposed a new national spatial database system consisting of a national space network as the basis for mapping and surveying.

The third class is the heart of opportunities—mobile users who want productivity, security, and safety. Their numbers are huge:

- Trucks 46 million
- Cars 144 million (Stolen cars is the growth industry in Europe)
- Railroad Cars 1.2 million
- Buses 70,000
- People How many million hikers, campers?
- Locomotives 78,000
- Ships 8,000
- Containers 500,000 (40,000 added each year)
- Aircraft 298,000

Of course, the global numbers are even much higher, as the world capitalizes on this free, global utility.

Differential navigation has been with us for some time. The surveyors, once again, were among the first to want and use it. In Texas, for example, we have 10 towers surveyors are using. There are commercial applications developed by AccuPoint, DCI, and John E. Chance and Associates, but there will be a big boost when Augmented GPS is available through the FAA's Wide Area Augmentation System and Local Area GPS. When we need accuracy in our business, whether static or mobile, we will have the capability for increased productivity through Augmented GPS *(Fig. OS-28)*.

The fourth class is the time community. As the data networks expand to transmit the planned 40 gigabytes per second, time for synchronization will be come dominant. This chart illustrates some of the highspeed networks being developed for traffic at this speed *(Fig. OS-29)*.

As Dr. Bob Bonometti of the White House has pointed out, GPS is the key to three major ways in which GPS impacts on the National Information Infrastructure, now the Global Information Infrastructure *(Fig. OS-30)*. The specs for GPS II, IIA, and IIR are 100 nanoseconds of accuracy for the time signal. The measured performance is about 30 nanoseconds. The Naval Observatory is trying for one picosecond, if you can imagine accuracy to that degree, let alone measure it.

But the big winners for the GPS revolution are the communications companies. All mobile users depend

UTILIZATION OF GPS BY THE NII

- WIDE-AREA SYNCHRONIZATION OF HIGH SPEED NETWORKS
  - TDMA NETWORKS
  - RAPID ACQUISITION OF FRAME SYNCHRONIZATION
  - SATELLITE SYSTEMS
- GLOBAL TIMING AND POSITIONING UTILITY TO TAG INFORMATION
  - VALIDATION OF INFORMATION TRANSMISSION
  - NOT ADDRESSED IN B-ISDN PROTOCOLS (YET!)
- NETWORK MANAGEMENT AND CONTROL FUNCTIONS
  - MOBILE USER POSITION DETERMINATION FOR NII ACCESS PORTS
    - PERSONAL PHONE NUMBERS
    - NOMADIC COMPUTING
  - ADVANCED DISTRIBUTED NETWORK INTELLIGENCE FOR "SITUATIONAL AWARENESS"
    - SMART PDA TERMINALS CHOOSE WIRELESS ACCESS MODES (CORDLESS, MICRO-CELLULAR, CELLULAR, SATELLITE...)
    - STOCHASTIC NETWORKING AMONG COOPERATIVE MOBILE PLATFORMS

Figure OS-30

OVERVIEW OF PROPOSED LEO TELECOMMUNICATIONS SATELLITE SYSTEMS (> 1 GH_Z)

	COMPANY	# SATELLITES	ORBIT: ALT	ORBIT: INCLINATION	FREQ	WT	COST	IOC	REMARKS
TELEDESIC	MICROSOFT (GATES); MCCAW	900 (40+4 IN EACH PLANE)	700 KM	21 PLANES 98.2° SUN SYNC	Ka Band 20-30 GHZ TDMA	750 KG	$15B	2001	Telephones broad band to remote areas & dev. countries. Packet Switching Network
IRIDIUM	MOTOROLA, LOCKHEED	66 (+7 SPARES)	780 KM	6 PLANES; 11 EACH	L-BAND TDMA	700 KG	$3.4B	1998	Worldwide digital cellular PCS. Russian & MacDac booster
GLOBAL STAR	LORAL QUALCOMM SPACE SYS.	48 (6X8) (+8 SPARES)	1390 KM 47°	8 PLANES 52°	16-25 MHz CDMA	400 KG	$1.8B	1997	Worldwide cellular voiced data & RDSS
ELLIPSO	ELIPSAT CORP./ WESTINGHOUSE FAIRCHILD	14-16 SATELLITES	2,900 KM X426 KM	ELIPTICAL 63.4°	L-BAND CDMA	175 KG	$650M	?	Mobile voice & RDSS for US
ODYSSEY	TRW	12-15	10,354 KM	55° 3 PLANES 4 SAT.	S&L CDMA	?	$1.3B ($52M/SAT)	1999	Voice data paging msg
CONSTELLATION (FORMERLY ARIES)	CONSTELLATION COMMUNICATIONS, INC. & DEFENSE SYSTEMS	48 4X12	1,000 KM	4 PLANES; CIRCULAR	16-65 GHZ S&L BAND CDMA	?	$300M ($1.5M/SAT)	1994 (FOC 1996)	Low cost RDSS for US. OBEX launch vehicle

Figure OS-31

on communications for tracking, for reporting location, for planning on-time delivery. Trucks are becoming mobile warehouses. They can be rerouted to most customers' demands or changing requirements.

As a result, we are going to see what I call the "Marriage Made in Orbit," the marriage of GPS and PCS. Our hand-held transceiver will show latitude/longitude and time with GPS accuracy. Now we can know where the Capitol Building is (N 38° 53' 24", W 77° 0' 32"); it is 249 feet from where we thought it was. If you want to locate the Eiffel Tower (N 48° 51' 35", E 20° 17' 40"), or the Tower of London (N 51° 30' 45", W 00° 04' 90"), just consult your Lat/Long for the precise location.

Before, I alluded to the coming torrent of electrons and protons. This chart is one of several that summarizes the explosion in proliferation of communications satellites at LEO *(Fig. OS-31)*. These are the "Little LEOS," small in size and deployed in low Earth orbit. The ORBCOMM satellite, for example, will weigh only 98 pounds and provide two-way paging.There are also the "Big LEOS," MEOs, LEOs, and GEOs yet to come. The numbers are nearly incredible. The planned Teledesic production is for over 2,000 satellites. As the Air Force study of the future of space, called Space Cast 2020, speculated, we may be approaching the need for space traffic control.

In summary, my vision is one of unlimited opportunities for productivity in business, safety in travel, and security everywhere. Time is no longer of the essence, it is the essence of future business. We users have a bright future ahead of us.

DR. SWAN: Thank you. Teledesic is really making IRIDIUM® a credibility, you know. We thought we had a lot of satellites, but its 840 is a lot. It is going to have to go from a 22-day assembly to a lot less than that.

Our next speaker is Mr. Courtney Stadd. He is a managing partner for Global Technology Ventures, a Maryland-based company providing a full spectrum of investment, business, marketing, and planning support to a broad range of technology clients. He has held several high level federal government positions. These assignments include senior director for Commercial Space Policy, the White House National Space Council; director, Office of Commercial Space Transportation, U.S. Department of Transportation; special assistant for Space Commerce, Office of the Space Secretary, U.S. Department of Commerce. His last job while he was in the government was the special assistant to the NASA Administrator and NASA Deputy Associate Administrator for the Office of Advanced Concepts in Technology. Please welcome Courtney Stadd.

MR. STADD: First of all, thank you very much. I am particularly pleased to speak this afternoon, because the last time I spoke about a space topic was as a private citizen before the House Appropriations Subcommittee. It asked me as part of a panel to talk about the future of the space program. And I, for better or for worse, held forth about my views that NASA's culture had long become an anathema to entrepreneurship in its broadest risk-taking definition—very much aided and abetted by the political system. This makes me all the more glad to see my good friend Bill Claybaugh touting a title called business manager. It's a good sign.

Unfortunately, I may have come across as more of a skeptic about our future in space than I intended at the time, and I hope that these remarks will show that I am, in fact, quite bullish about our opportunities in space.

Maybe because much of my company's technology client base is caught up in the earth-shaking realities of the digital electronics revolution, it strikes me that sometimes our perspective in the space community seems a bit disconnected from the real world many of us face when we leave conferences like this and return to our jobs. But it is indeed within the context of those realities that opportunities for space entreprenureship need to be calibrated.

A few anecdotes about the incredible changes changing the economic landscape will, I hope, make my point. While many of us in the space community watch in dismay as government and industry announce pending payroll cuts, keep in mind that we are just playing catch up with a parallel universe. To wit: in the last few years all the blue chips, be it the Boeings, the Kodaks, the DECs, the Phillips, the Compaqs, etc., have been undergoing major restructuring which often decimates the work force, especially the white collars. We have not seen the last of the empowerment revolution by a long shot.

Insecurity and gambling on the next opportunity wave is a fundamental feature of life in the technology-based world we now find ourselves in. A random walk through today's technology-based commercial marketplace would have seemed purely fanciful to attendees of the First National Space Symposium 11 years ago. Just imagine telling folks back then about a Hewlett Packard that runs its 9,000 person ink-jet factory with a headquarters staff of four people. Nintendo with only 892 workers racks up $5.5 billion in sales—$6 million per employee—and ranks third in '92 profits in all of Japan. (These anecdotes are taken from Tom Peter's *The Seminar: Crazy Times Call for Crazy Organizations,* Vintage, NY, 1994.)

Cheap technology has penetrated economies around the world. In '94 we Americans spent more on PCs than on TVs, and today more than 5,000 Vietnamese own digital cellular phones. All of us in this room, if you took an accounting, face an average of 300 program electronic micro-controllers each day of our lives. In my case, my own Cannon camera has more intelligence than an early '80s version of the Apple II.

The Space Age that gave us the Digital Age is turning the economic world upside down and creating endless entrepreneurial opportunities. Of course this brave new world is giving all of us one hell of a beating. The AT&Ts of the world have taken billions of dollars in charges since '84 to get rid of obsolete jobs and equipment. The IBMs, the DECs, the Wang Laboratories are still recovering from the near death blow dealt by the microprocessor. And as an example of how zany the world has become, who would have thought Taiwan's Acer Inc., an aggressive PC price cutter, would move most of its assembly plant to the U.S. market? To San Jose, in fact. Where product cycles are the shortest, such as PCs, factories have remained inside the biggest markets—the U.S. and Japan—to save shipping time. And again, who would have guessed that would be the situation a couple of years ago?

With all the talk of downsizing and outsourcing in recent years, those of us in the technology investment sector are not surprised to learn that Manpower, Inc., the nation's largest provider of temporary workers, now has more than a half million people on its roles. Indeed, the nation's temporary work force has grown 250 percent since 1982, while the total work force has risen by only 20 percent. And more and more firms are specializing in providing temporary CEOs and VPs and senior project managers to networked companies that view, according to management guru Tom Peters, "permanence as a mortal sin."

Not a week goes by that I don't receive a call from an old friend in NASA or aerospace company setting out a shingle as a management executive trying to play some role in this networked world.

As I said, the aerospace world is certainly playing catch up to the upheavals that are reshaping major chunks of our society. Every time the political system (Republicans or Democrats) tries to outguess the marketplace when it comes to the future world of this technology driven society of ours, it's wrong. It's often dead wrong. And since our space world is fundamentally dependent on gobs of silicon and tons of chips, it is critical to be mindful of the new economics shaping high-tech products.

The Space Age that gave us the Digital Age is turning the economic world upside down and creating endless entrepreneurial opportunities.

Last week's *Business Week* contained an article titled "Technology Paradox," which I thought did an excellent job of describing this new economic reality.

Remember the panic surrounding DRAMs, the dynamic random access memory chips, a few years ago? U.S. makers fled the marketplace in the wake of alleged Japanese dumping. Well, guess what happened? The market ultimately found new uses—e.g., Windows software—which are pervasive and gobble megabytes of DRAMs. Unit prices fell; gross revenues soared. And on the horizon we see a new wave of demand in the form of computers that obey spoken commands and communicate in 3-D images. Beyond that, as the magazine points out, perhaps believable Virtual Reality? What about intelligent artificial intelligence? It is highly probable that someone in this audience is either working on some space-derived technology (after all, aerospace was the big driver with VR) that will take us another generation beyond in terms of applications.

In the Digital Age, the economy and society are profoundly reshaping themselves to take advantage of a demand for digital resources that are infinitely elastic. Be it computers that talk and whose messages can be carried over satellite-based networks, or satellites that track stolen vehicles, or containerized packages, or combined with digital-based smart car technologies to provide customized tracking of corporate and personal assets. The list goes on and on, truly limited only by the regulatory environment and the imagina-

tion of the corporate CEOs and their organizations and alliances.

It is important to understand that our very survival depends on acknowledging that the fundamentals many of us in this room grew up with—multiple-year business strategic plans, deliberate pacing of multiyear product cycles (a world in which NASA's technology culture itself was formed)—no longer exists. The ultimate paradox was summarized by our moderator's former boss, George Fisher, now chairman and CEO of Eastman Kodak. He said, "The only thing that matters is if the exponential growth of your market is faster than the exponential decline of your prices."

In the void left by the decline in federal space purchasing power, we see the re-emergence of creative funding ideas that used to be kicked around 10, 15 years ago.

And that is the world to which the digital-based information products of space—remote sensing, GPS, LEO telecommunications, direct broadcast—and other space commerce application opportunities on the horizon must learn to adjust in order to succeed.

That issue of *Business Week* I referred to earlier contains a compelling example of what I'm referring to—the emergence of digital TV satellites. GM Hughes Electronics began planning this project four years ago after it calculated that the necessary components, then far too costly, were on the verge of becoming affordable. A European partner, France's Thompson, was able to offer a home dish and decoder starting at $699. Since last June more than 400,000 American homes have signed up.

Basing a costly investment on a technology too pricey at the time the business plan was drawn up sounds a little crazy. Turns out to be very canny. That's the crazy world we're living in today. But the fact of the matter is that the folks who envisioned this particular opportunity realized that every 18 months or so improvements in chip-making technology make it possible to double the performance of silicon at no increase in price. Around the year 2000, high volume microprocessors will execute more than one billion instructions per second, allowing designers to generate a limitless range of products from holographic videoconferencing to personal digital assistance. There is no doubt that a successor to today's remote sensing and GPS ventures will be intimately involved in some aspects of these new business opportunities.

Having tried, however feebly, to underscore the wacky and the bizarre marketplace awaiting space-related opportunities, allow me to spend a moment or two focusing specifically on the paradoxical forces shaping the space arena. These are forces that appear to wreak havoc for champions of the status quo, but they pose tremendous entrepreneurial opportunity for the risk takers among us.

Notwithstanding the tremendous inertia and the agonizingly slow process that appears associated with it from time to time, we are, I think, seeing incremental steps in the transition from a government-planned economy which, after all, has characterized the civil space program to one that is more market-based. Although NASA's RLV, Lunar Prospector, Discovery programs, and so forth are indeed a minuscule part of the overall civil space budget, there's no denying that the trend is going in the right direction. And for the first time in memory, the government and industry seem to be, if not in lockstep, at least well coordinated in their efforts to coalesce around a strategy for building low-cost launch systems fundamental to realizing many of the space opportunities outside the satellite-based information areas we've been talking about.

At the same time, federal space purchasing power is under attack with the very real prospect of it being reduced by one-third or more in the next few years. This real reduction in spending is the real motivation, quite frankly, behind formerly verboten topics such as seeking to privatize shuttle operations. But now these things are being reopened for re-examination and provide opportunities as the roles and missions between the public and private sectors are being redefined.

Under the reinvigorated leadership of the House, specifically Bob Walker of the House Committee on Science, Congress appears open to a range of what I call "risk mitigation tools," which are fundamental to those of us who work in the investment world. Examples include tax relief on space products for a limited period of time, perhaps even some forms of termination liability, innovative space privatization schemes, and so forth.

And there also appears to be, as loony as it may seem at first, an emergence of a grass-roots advocacy for opening up space frontier to the population-at-large. This is a movement expressing its deep dissatisfaction at a situation where the world's greatest democracy has supported a program that has become the province of a small, technically trained elite. One of the leaders of this movement is, in fact, Tom Rogers, who spoke this morning.

In the post Cold War era, this perspective is shaping an environment (which may take a generation or two or more to come to fruition) that may, indeed, support opportunities such as space tourism, and space sports down the road. In the post Cold War era, the international space marketplace is opening up rapidly to commercial space opportunities. Name the joint venture across the Atlantic or across the Pacific, and, if it hasn't been tried, you can bet it's on somebody's drawing board as we meet here today.

In the void left by the decline in federal space purchasing power, we see the re-emergence of creative funding ideas that used to be kicked around 10, 15

years ago. I'm hearing people talk about space trust fund mechanisms, privately funded in part. I'm hearing about space prizes. People are now resurrecting the idea of privately supported prizes not unlike what we saw in the pioneering age of aviation. In my case, I'm developing a nonprofit that provides small private grants to fledgling space entrepreneurial ventures.

Since I am involved in the capital world, let me very quickly say that there's no shortage of it. In the '80s businesses raised $126 billion in the capital markets. Ten years later they raised over $1 trillion. Indeed last year, for the first time ever, investment company assets now exceed the total deposits of the commercial banking system. Who says the '90s are not as go-go as the '80s in their own way?

But little of that capital is going into financing space-related ventures until the near term space projects (low earth orbiting Comsats, such as Iridium) show some payoffs, and until the political system demonstrates a commitment to the public-private rhetoric we've been hearing recently until today's CEOs of tomorrow's space ventures are able to creatively link their products and services to the digital global economy.

I will conclude with some potential investment opportunites in space commerce over the next few years. I think there's an incredible, suppressed demand out there for mobile telecommunications, and I think that Iridium and one or two others providing voice capability will be successful pathfinders. I see at least two non-voice LEOs succeeding in creating a blockbuster industry—opening up literally new industries from asset management to global E-Mail, delivery systems, global emergency related systems, satellite-based CD digital radio services, and satellite-based digital TV. GPS is an unbelievable marketplace. The government predicts a four to five billion dollar GPS market by the end of the decade. I think it will be double that and I'm probably being conservative. GPS is an area my company is very excited about. It is a business that's growing by rapidily, it appears, every day.

Satellite-based tracking and positioning services, I believe, will be a several hundred million dollar industry very quickly in the next couple of years. And certainly satellite remote sensing. It's always easy to outguess the bureaucrats. Commerce says at least $2 billion by the end of the decade. Certainly at least double that, if not more, would be a very safe bet, I think, just based on suppressed demand.

It's very hard to predict these trajectories for any of these technologies. For example, one of our clients has a pioneering and versatile low-cost electronic tagging system using smart-card technology. You combine that with any one of the various satellite tracking and positioning ventures, and you could have incredible implications for customizing various and sundry markets.

I think there's some exciting potential for at least a couple of the commercial spaceports that are out there. And I believe you'll see a resurrection of some of the old platform concepts—the use of the external tank, for example—in the next few years. Finally, companies such as Lunar Corporation have talked about the commercial potential for telerobotics on other planetary surfaces.

So I would conclude by saying that what we can be sure of is that, notwithstanding the fiscal realities and the economic and political craziness of the world we all face, that this is an incredible moment, I think, in our history in terms of developing the space frontier. I believe that we have a chance to ensure that the next "Space Age" may be even richer, more varied, and more empowering than the one that 25 years ago motivated many of us to be part of what is the ultimate frontier, I believe, for opportunities. Thank you for your time.

DR. SWAN: Thank you. I'm glad to hear that there's going to be a lot of money out there. That's good. Lots of opportunities.

Q&A

DR. SWAN: We've been given some questions here that I'll ask of the members.

The first question is for Mr. Nanz. The International French Subsidy of the SPOT system has made SPOT data available. Why is this called commercial? That's a loaded question, so I thought I'd start off with that.

MR. NANZ: I'm happy to have that question. The answer is that we are in the midst of a 10-year time schedule to become totally commercial. And in the early days, we were subsidized (not the right word), but the satellite was designed, launched, and managed by CNES. As we progressed through this decade, I know because my chief financial officer reminds me every day, we are paying more and more of our way to that system.

DR. SWAN: Thank you. This question is for Dr. Kane. With GPS available to the whole world, how is cost shared and how can a potentially unfriendly user be denied its use?

DR. KANE: The answer to the first part of the question is that there is no cost sharing with users. GPS is free to everyone, globally. The costs of the system are borne by the U.S. taxpayer and funded through the Air Force budget.

As for the second question, I've been asked the question for 30 years. It dates back to the very beginning, before it was GPS, and before we had satellites for warfare. How do you deny it to the enemy? It's what we call the continuing true dilemma. That's what

faces the Air Force and DoD every day: what to do about this problem?

One answer is to deny the enemy access to the Precision Code (the P Code); the other is to modulate the clear code through a technique called Selective Availability (SA). By using SA, we degrade the precision of the clear code. That affects the enemy; but we also degrade the signal for civil users.

The villain, of course, in this problem is GPS, because it sends out signals. I've been trying to tell the "blue suiters" for these 30 years that GPS is like bullets, airplanes, guided missiles—it's a resource to use in war. Sometimes you have the signal on; sometimes you have it off. What is the commander trying to do in the war at that time? Why doesn't he use GPS like he does anything else? To make his forces more effective or to deny the enemy forces from being effective.

Everyone gasps at the idea to try to do that. But to me, if Dr. Swan can have his IRIDIUM® operate over the U.S. and not over Iraq, why can't GPS do that? There's a barrier here that says the problem is GPS; the real problem is that we have to recognize that fighting wars include new ways of thinking about GPS and all satellites. My solution is to think about GPS in the military environment. And it's not a U.S. problem. I ask my French friends the same question. "O.K., you're having problems with Algeria. You think the Algerians have a guided missile. Do you want to call up President Clinton or President Whomever and say Please turn GPS off'?" Then the rest of the world gets mad at the U.S. for turning it off.

There is no single answer to this question. It's circumstance dependent. You have to deal with the operational situation at the specific time. But we who build and operate the satellites have to be much more sophisticated in how we control the satellites. When the Block 2F is put together and they're able to control the satellite within six seconds, we ought to be considering what to do with GPS as a war fighting resource. That's the only way to solve the dilemma.

This present point of view is too narrow. The answer lies in thinking about war.

DR. SWAN: Thank you. The next question is for Mr. Claybaugh. You say the RLV effort is what is going to bring down the price per pound ratio that is so important to the future marketing activities. Isn't this what the shuttle was supposed to do? Yet it is the most expensive launch vehicle for small payloads. Why is the current RLV effort any different?

MR. CLAYBAUGH: I'd note at least three differences, starting with the fact that the shuttle was built by bureaucrats and if, *if*, an RLV is built, it will be built by American industry. In addition, I would suggest that although the shuttle is unquestionably an expensive asset, and in some ways the most expensive asset we fly, it's worth remembering the shuttle is a flying space station. The 250,000 pounds the shuttle puts in orbit every time it flies includes a very capable spacecraft with on-board power, the ability to keep people alive for weeks, and the ability to maneuver back through the Earth's atmosphere and do it all again. To think of the shuttle as comparable to an expendable launch vehicle is rather a lot like thinking of the space station as if it were a launch vehicle.

And lastly, I would note that a major emphasis of the RLV program is operations. The central driver on X-34 and subsequently X-33, from our point of view, from what the government is acquiring in these programs, is driving technology towards very, very highly operable systems. We are privately looking for systems that can turn around in one day. That may not be the official contracted number, but that is what we are telling our people now is the goal: Build us fully reusable launch vehicles that can be flown every day.

I think, in combination, all that is vastly different than the shuttle.

DR. SWAN: Thank you. The next question is for Mr. Edwards. How is EOSAT storing the vast quantities it receives and how long is that archived?

MR. EDWARDS: EOSAT archives Landsat data in conjunction with the government-run EROS Data Center (EDC). Newly acquired TM data are archived for the short term at an EOSAT facility in the Washington, D.C. area. This ensures ready access by our customers. Eventually all Landsat tapes, however, are shipped to EDC for long-term archiving. Data that is over 10 years old is available to the public from EDC. This includes all of the original ERTS-1 (Landsat 1) data beginning in 1972.

DR. SWAN: Thank you. The next one is for the moderator. How does the IRIDIUM® integration assembly and test experience doing it in less than 22 days compare to other high-volume—e.g. Global star—satellite production experience? The answer is, I really don't know. I'm very familiar with our system. We're leading the way as far as I can tell in the sense of hardware. We started first—we received our financing first—so we're a little bit ahead of the others. Whether that gets us into orbit, of course the market is still up in the air. We're still working those issues. I do know that Orbcom, if it is going to put up its 30 satellites in a cost effective manner, would have to do a different approach than the standard old government approach. Globalstar will certainly have to be different. Globalstar has an advantage, similar to Hughes and to the RCA, GE, and Lockheed Martin, in its commercial geosynchronous satellites experience. The time frame is a lot shorter in that business. Loral has an advantage in that it's starting from that point. So the answer is, I don't know, but we should find out when the first to market comes out and that's really what counts, first to market—get the revenue.

O.K., Dr. Kane, what sort of policing mechanism will be needed to keep the satellites from being jammed or harmed by rogue nations?

DR. KANE: That's essentially a variation of the question I answered earlier. When I used to brief on the idea of GPS, we had a scenario of flying a fighter plane through the Fulda Gap to bomb the Red Army. The opponents of GPS would have the Soviets sow hundreds of jammers in the ground and around the Gap. And I'd say, "O.K. I'll shoot the jammers." "You can't shoot the jammers." "Why can't you shoot the jammers?" "If you shoot the jammers, the fighter gets through. But we don't want GPS, so don't shoot the jammers."

The whole problem is so complex that people pick on pieces and try to answer it in that context. There are ways to prevent jamming and there are ways to use jamming. You may want to jam the satellites so the Iraqis can't use GPS. You may want to jam only in his territory or only in our territory. All those are games you play in warfare. The offense does something and the defense does something. In the information war that's coming, GPS is one of the principal resources to be used by the offense and defense. It is integrated with the communications, the surveillance satellites, and multi-spectral imagery in the Command Center. And the commander decides that today we jam from 6:00 to 10:00 because we're expecting an attack at that time, or we may not want to jam because we're expecting some C-5s to arrive between 6:00 and 10:00. It's not a simple, easy answer. It's a commander's problem to think through how to use this resource—GPS in a combat environment.

DR. SWAN: The final question was addressed to the total panel. Is the demand and market size large enough to provide attractive returns on the huge initial investments required by companies pursuing new satellite applications in direct broadcast satellites, remote sensing, mobile communications, etc.? If yes, what will prohibit space technology manufacturers from entering these markets and intensifying competition for those already operating satellite networks?

I think I'll answer for the panel. That's what we're seeing in the environment today. The traditional corporations, international organizations, INMARSAT, INTELSAT, AT&T, long lines are facing tough competition. That's where a lot of technological companies are going. The opportunities are there.

I would like to thank the members of this panel and the United States Space Foundation for the chance to show that the global opportunities in space business are there. The excitement is growing. Space is changing. We, the professionals, in this room and our friends elsewhere need to trade the vision and the reality. I recommend that we aggressively pursue the opportunities and remember to have fun along the way.

MR. PAYNE: Thank you to the session speakers and to Dr. Swan for developing and moderating such an outstanding and informative session. Thank you very much.

At this time we're going to take a 15-minute break sponsored by Digital Electronics Corporation. We will reconvene promptly at 3:45.

We Can Achieve Competitive Vision with Acquisition Reality

Master Moderator: **David Payne**
Manager, Spacecraft Technology
TRW Space & Electronics Group

Speakers:

Bernard P. Randolph
Vice President & Special Assistant to the Executive Vice President and General Manager
TRW Space & Electronics Group

Dr. Brenda Forman
Director, Federal Planning & Policy Analysis
Lockheed Martin Corporation

Joseph P. Zimonis
Vice President, Space Propulsion Operations
UTC-USBI

Frank Weaver
Director, Office of Commercial Space Transportation
U.S. Department of Transportation

Douglas A. Heydon
President
Arianespace, Inc.

James P. Noblitt
Vice President & General Manager
Missiles & Space Division
Boeing Defense & Space Group

MR. PAYNE: Our final session today will examine the acquisition process, which will be moderated by Randy Randolph. Mr. Randolph is vice president and special assistant to the executive vice president and general manager of TRW Space & Electronics Group. In that capacity, Mr. Randolph leads and coordinates special study activities within and across TRW groups.

He joined TRW after 35 years of distinguished service in the United States Air Force, where he retired with the rank of general. His final assignment was as commander of the Air Force Systems Command. Mr. Randolph's military decorations include the Distinguished Service Medal, the Legion of Merit, a Bronze Star for service in the Vietnam conflict, the Meritorious Service Medal, the Air Force Commendation Medal and the Presidential Unit Citation.

Mr. Randolph holds a bachelor of science degree from Xavier University in chemistry, a bachelor and master of science in electrical engineering from the University of North Dakota, and a master's in business administration from Auburn University. And in 1989, the University of North Dakota awarded him an honorary doctorate in engineering.

He's a member of the Defense Science Board, the Defense Intelligence Agency, and the Advisory Board for the Lincoln Laboratory at Massachusetts Institute of Technology. Please welcome our Acquisition Reality Chairman, Mr. Randy Randolph.

MR. RANDOLPH: Thank you very much, Dave, and thank you folks for joining us at this last session. I recognize that you've had the firehose treatment all day, so I appreciate your bravery in staying for this last session. In fact, one of our panel members said, "You know, after hearing all that great information all day, by the time it gets to us the whole audience will be brain dead." Well, the fact of the matter is, I know you're not brain dead, but you're probably a little bit tired of listening to us. Hopefully we've got a stimulating session for you to think about, debate about, and ask some questions about. And that's the part that we're going to work with you on.

The subject is "We Can Achieve Competitive Vision with Acquisition Reality." That's a nice subject, but quite frankly, what I'd like to do is change the name of the topic to "We *must* achieve competitive vision in DoD acquisition." Simply stated, we've got to get rid of the bells and whistles. There isn't any more room for bells and whistles. We've got to simply reduce the number of people involved. We've got to be able to reduce the dollars. I know one of the speakers earlier today said things in the space world are low cost enough, we don't need to think about reducing the dollars. But let's face it folks, when the taxpayers see that $15 billion space budget, they want to reduce it. Believe me. And quite frankly (and you may disagree with me on this and if you do, say so), I think that we in the industry have to lead the charge. We are the folks who I really think have the wherewithal and quite frankly, as someone said some time ago, "if you ain't the lead dog, the scenery never changes." We want the scenery to change so we want to be the lead dog, and that's what we've got to concentrate on doing.

Both President Clinton and Dr. Perry have talked a lot about acquisition reform. What they're really talking about is that the budget is just not there to buy all of the equipment that the troops need if we continue at the levels that we are now. Therefore we need to think about ways to streamline, and about ways to reduce costs. Affordability is the watchword. You're going to hear that again pretty soon. We must buy the

kind of equipment that we need in order to get the job done. But we've got to get rid of the paper.

Folks, we are sinking in paper. Our backs are up against the wall. Adlai Stevenson once said Americans often can't see the handwriting on the wall until they're backs are up against the wall, and that's where we are now. Believe me, I'm beginning to see the handwriting and hopefully you are too.

Let's talk a little bit about this business of reform. I know some of you out there are saying, "Wait a minute. What the heck are you talking about—reform?" The NRO started out as a "reform" organization. The NRO knows how to do business, and it's done business in a streamlined way for a long time. Let me tell you something, folks. As far as in the military space business is concerned, the NRO was the dumbest idea ever created in the space business. Now everybody says, "Whoa." I'm not calling the NRO dumb—don't get me wrong. The idea that space intelligence was so important that we had to get that out of the bureaucracy, that's fine. But just think about what the opposite says. On the other hand, military space is *not* that important to get out of the bureaucracy, so we'll let the military space program suffer under the bureaucracy. Meanwhile we'll streamline the other side. That doesn't make sense.

There's no need for two different programs. And, of course, Jeff Harris is going to fix that, I hope; and he's going to talk a little bit about that, I think, tomorrow. But let's stop and think of the costs associated with having those two different programs, and that says that we've *got* to do something about it and, quite frankly, as a taxpayer, I object to the different approaches to working the problem.

That's where I stand on the subject. We've got a lot of outstanding panelists who are going to give us some good words and, in fact, they're going to address a number of the questions and a number of the issues that were brought up this morning.

By the way, one thing I should say right off the bat. I heard somebody say it's going to take 10 years to acquire a weather satellite. Hopefully, it's not going to take that long with acquisition reform. I'm looking at like six to seven years and, just think, we'll save a lot of money.

Space propulsion was raised as an issue, and of course, Joe Zimonis is an expert in that area. Commercial use was talked about a lot, and Frank Weaver is an expert in that area. Industrial cooperation was discussed a lot, and Doug Heydon is an expert there. Military space has been talked about, and Jim Noblitt is an expert. And, of course, space policy is definitely something that we all need to discuss, and Brenda Forman is an expert in that area.

We're going to start, in fact, with Brenda, and I'm sure most of you know Brenda Forman. She's an expert in the business. She's a widely published author on space policy and trade policy. She has a monthly column for the U.S. Space Foundation. She writes in *Space News* and *Acquisition Review Quarterly*. She joined Lockheed in 1983 as corporate director of marketing policy and before that she was with OSD in international security affairs and then with MITRE. She developed a course which is quite highly regarded at the University of Southern California Graduate School of Engineering and, in fact, she's teaching that course right now. As you know, she has a Ph.D. in political science, is a member of Phi Beta Kappa, a recipient of the Department of Defense Distinguished Civilian Service Award, was an honorable mention honoree at the 27th Annual Wright Brothers Banquet, the Wright Women.

Ladies and gentlemen, please help me welcome Dr. Brenda Forman.

. . . the budget is just not there to buy all of the equipment that the troops need if we continue at the levels that we are now. Therefore we need to think about ways to streamline, and about ways to reduce costs. Affordability is the watchword.

DR. FORMAN: In policy terms, procurement reform is a "golden oldie." For some 40 years, a parade of prestigious blue ribbon panels has identified essentially the same set of problems—the system takes too long, it costs too much, it discourages innovation by penalizing risk-taking, and when it finally does field a weapon system, the technology involved is often already passé.

But the status quo is essentially impervious to this sort of logic or expertise, because that is not the basis of its appeal to its multifarious constituents. Logic and expertise are irrelevant to this issue: wise counsel is largely wasted effort because the procurement system as we know and love it today is the end product of some 40 years of relentless politicization. It is by now so deeply rooted that it is unlikely *ever* to be pruned back to what industry, at least, would regard as truly rational levels.

And why? Because the system as it exists today nourishes an enormous and varied constituency. All of whose participants command powerful political resources. From *their* point of view, the system works just fine!

Viewed in this light, it's no wonder that 40 years of reform efforts haven't gotten us anywhere. Because reform, by definition, seeks to eliminate precisely the inefficiencies that have helped to build the status quo's formidable constituency and cement its resistance to change.

When reform finds itself unwelcome in so many quarters, it tells you that a lot of people are quite

content, thank you, with the status quo. This has, in short, become a system that feeds on itself—and nobody is innocent!

It's easy, for example, to blame government auditors for resisting reform in order to hang onto their jobs. But remember, for every government auditing team, the contractor being audited must field its own counterpart team. Both teams thereby become dependent on the system for their jobs and livelihood—i.e., part of the system's constituency.

An ambitious military officer eyeing his next promotion knows he must get his program manager ticket punched along the way. He also knows that in so dangerously politicized an environment, he cannot afford any misstep, no matter how small. Detailed oversight authority provides him with an important tool for demonstrating his total control over his program and his complete knowledge of everything going on in it. So even though the total cost of that oversight structure subtracts from the dollars available for his program, he may not want to give it up. So he too finds himself perforce part of the system's constituency.

...reform, by definition, seeks to eliminate precisely the inefficiencies that have helped to build the status quo's formidable constituency and cement its resistance to change.

A congressman—or sometimes even more often, a congressional staffer—sees a chance to make some political hay by portraying himself as the defender of the taxpayer's interests. He (or she) seizes on some infraction (real or perceived) of the system's convoluted regulations and sponsors a piece of legislation that adds yet a further oversight layer to the process—all in the name of eliminating waste, fraud, and abuse. The system has thereby provided him with an opportunity for what every politician wants: *political visibility*. As an ex-staffer friend put it, "Press is almost like an aphrodisiac for a congressional politician." Furthermore, that piece of legislation is now his baby; so long as he remains in office, he will resist its appeal. He thereby joins the systems constituency.

Then there's the curious symbiosis between audit and oversight on the one hand and the requirements process on the other. Everyone knows that over-specification and excessive requirements—a.k.a. "gold-plating"—add to a weapon system's cost. What is less widely recognized is the way these also inflate the oversight burden. The more requirements that can be written into the contract, the more requirements those engender for audits and oversights down the road. There is thus a mutuality of interest between those in charge of generating requirements and those in charge of verifying that those requirements are met. Both groups benefit from the system and thereby become part of its constituency.

And if the secret truth be told, the long-suffering contractors are not always innocent in all this either. We live in the Age of Protests. You lose a competition, it's almost predetermined that you lodge a protest—no matter how flimsy the grounds. This can be a very handy-dandy competitive tool. At the very least, it may slow down your opposition. If you're lucky, the auditors will find something to object to. And if you're *very* lucky, the ensuing fuss might even throw him out of the running.

Meanwhile, there's the recalcitrant problem of the media. Headlines and horror stories drive the system. Everyone lives in fear of the six o'clock news. And the Congress' stock cure for any problem has been to add more to the oversight!

By now, for example, I am royally sick of hearing those antique catch-phrases, "the $600 toilet seat," the "$9,000 coffee maker," or the "spare parts scandal." I do not recall a single news account's making any effort to explain how those supposedly shocking price tags were forced by the bizarre requirements the system imposes on contractors for allocating G&A expenses. Nor do I recall any news account that talked about the wholly weird requirements process that directed that the coffee-maker continue brewing coffee at 9 (or was it 12?) Gs—when the crew presumably would be reduced to a bloody paste on the cockpit floor!

What *has* at long last begun to make a dent in this political phalanx is the fact that the system is becoming just plain unaffordable. By now, this monster gobbles somewhere between 20 to 50 percent by the most recent estimates.

So long as dollars were plentiful, the country could afford that overhead burden and still buy weapons it needed. But as budgets have shrunk in the post-Cold War world, every dollar devoted to overhead is a dollar unavailable for buying real weapons systems.

The process, in short, is on its way to consuming the product.

But remember: this is a profoundly politicized system that has had nearly a half century to become deeply institutionalized. So it remains to be seen, for example, whether the implementing regs for the Acquisition Streamlining Act actually embody the spirit of the legislation—or whether they are framed to maintain as much of the older structure as possible. Early indications are that the regs are being framed to preserve essentially *all* the older structure.

None of the companies I've talked to have seen any meaningful reduction in oversight. Indeed, several report instead that there is *more* oversight. The audit and oversight workforce *is* coming down, but not at anything like the rate at which defense spending has

been dropped.

So what is to be done? The Defense Science Board's 1993 Task Force Report on the procurement system estimated that it would take four to five years of sustained political effort to effect any lasting systemic change.

Is that sort of policy continuity even possible in Washington? I wouldn't want to bet on it. Washington is a town whose political compass can and does veer dramatically after every election. Every incoming administration junks its predecessor's files. Yesterday's hot policy topics are today's old news.

In my opinion, therefore, reform momentum will survive only if the issue of *affordability* is kept hot, front and center. Reform for its own sake has never been able to muster a constituency remotely resembling that commanded by the status quo. Only if the existing system is increasingly seen to consume dollars that would otherwise by available for maintaining need programs (or even starting new ones) can it at long last become politically vulnerable.

The necessary leadership will have to come from all directions: The Clinton White House and the Petty Pentagon have assertively pursued reform. The previous Congress provided essential support and legislation. But what will this new Republican Congress do?

Right now, that's a pretty murky question. Procurement reform isn't part of the Contract With America—although it probably ought to be! And if reduced oversight is to succeed, it will require that the Congress allow it to happen. And the Congress has been historically unfriendly to such efforts.

Reportedly, too, some of the fiercest advocates of ever-increasing oversight, ousted by the Democratic defeat, have simply crossed the river to take up key positions in . . . the Pentagon!

For years now, the procurement system has provided ambitious congressmen with a rich supply of sound bites and political posturing. We know that the new Congress proclaims its dedication to budgetary economy. We know it wants to shore up defense spending. And we know the oversight burden is taking a growing bite out of available defense resources. Still, it seems unlikely that the Congress will be able to resist the eternal political urge to use even an obscure infraction of ambiguous regs as a political stick to beat up on the opposition. Doing so may actually *injure* the nation's long-term security by setting back the process of reform—but if history is any indicator, the lure of political advantage may be too much to resist.

So, in sum, we've made some gains, but the outlook is looking pretty stormy. Furthermore, any progress will always be fragile because as soon as something goes wrong, all the political forces that have collectively built this monster will pounce on the problem as an excuse to reconstitute it.

So what do we do to tame this dragon? First and foremost, we have to bear down hard on the issue of affordability. The Congress and the American public must be made to understand that procurement reform has become a national security issue. With budgets shrinking, the nation can no longer afford the luxury of the un-reformed system. As unpopular as reform is likely to be to the existing system's myriad beneficiaries, the nation's present and future safety requires it.

To that end, the leadership—in both the Congress and the Administration—must join forces to revive and maintain last year's nascent momentum for reform. This neither is nor should be a partisan issue. We're talking the national interest and the nation's security here—and that should concern Republicans and Democrats alike, with equal intensity.

. . . if reduced oversight is to succeed, it will require that the Congress allow it to happen. And the Congress has been historically unfriendly to such efforts.

Next, no effort to significantly streamline audit and oversight is likely to succeed unless it is coupled with effective discipline in the requirements process. There must be a determined effort to eliminate non-value-added requirements at the RFP and source selection stage. Along with this, people who state non-performance-related requirements must be convincingly restrained and disciplined. Procurement and contracting officers must be made aware that in a changed, budget-constrained world, their reputations need to rest on the *thinness* rather than the thickness of contracts.

Next, the protest process must be rationalized to eliminate the knee-jerk, frivolous or just plain vengeful protest of a legitimate and carefully awarded win. The ensuing delays needlessly waste time, money, and resources which neither the government nor the contractors can afford.

And somewhere, somehow, the leadership in DoD, the White House and the Congress has to put some steel in its spine and stand up to the media for its people and its principles. Yes, everyone lives in fear of the media, but this mess isn't going to be improved by always running scared. Somewhere along the line, we need to stand and deliver.

Will we succeed? In part, possibly. We may manage to tame the dragon, but I don't expect us to slay it. Still, every success, even if small, will be welcome. The message of the hour may just be Keep On Truckin'.

MR. RANDOLPH: Brenda, I'm really pleased to see that you love the system so well. Our next speaker is Joe Zimonis. Joe is vice president of Pratt & Whitney Space Propulsion Operations. He has managed a NASA prime contractor for the space shuttle. He has

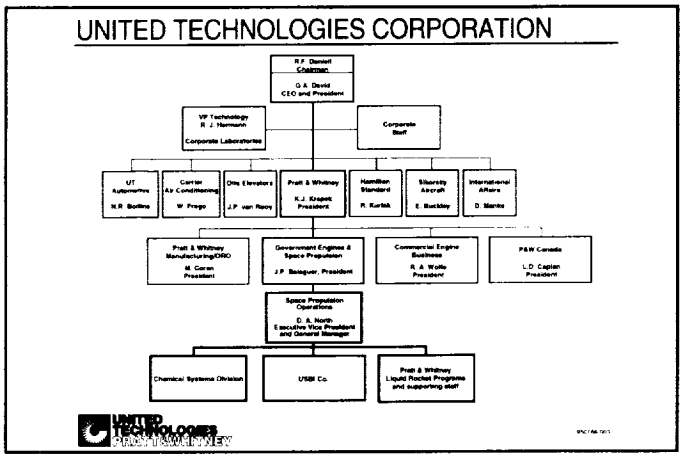

Figure AR-1

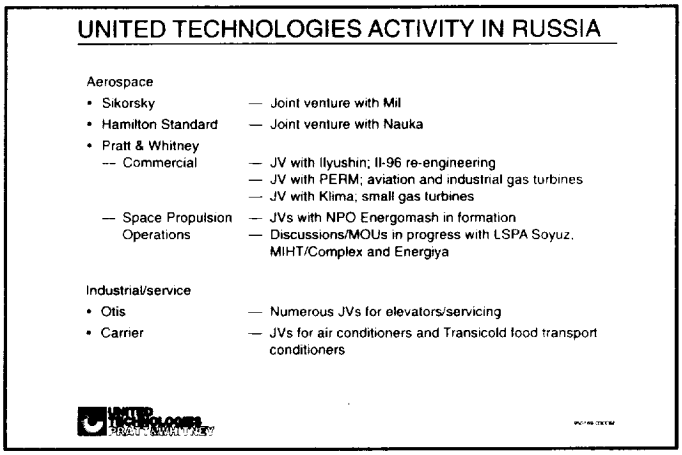

Figure AR-2

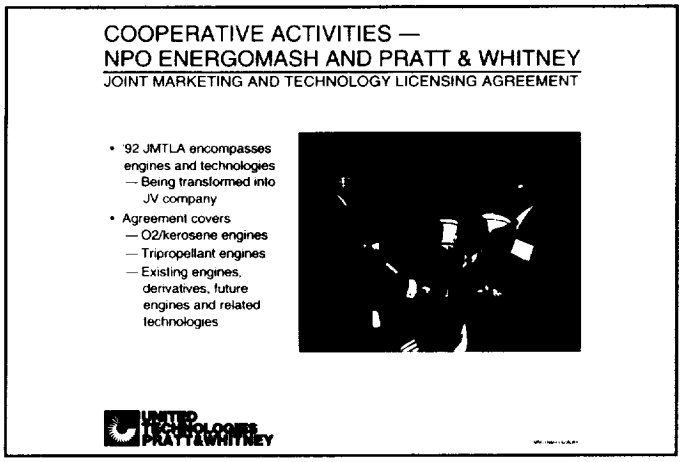

Figure AR-3

worked in Pratt & Whitney's Liquid Space Propulsion program. In fact, he's been with Pratt & Whitney 36 years, so that makes the intro pretty short. Simply to say he's a Pratt & Whitney-type fellow who happens to have worked in Connecticut, Florida, and Alabama. He holds a bachelor's degree in chemical engineering from Worchester Institute, and a master's degree from Renselear Polytech Institute. Ladies and gentlemen, please help me welcome Joe Zimonis.

MR. ZIMONIS: I know many of you in the audience are working various programs and deals within Russia with various companies. And I'm here to tell you a little bit about a relationship that's being established between Pratt & Whitney Space Propulsion and a company in Russia called NPO Energomash.

I'm going to do a little bit of an overview of our space propulsion operations and those of NPO Energomash. I'll be showing a few organizational slides, but look upon the slides macroscopically, because I want to use them to portray areas of synergism and an area where there are complementary products. Then I'm going to talk a little bit about the potential for the market and business environment, at least as I knew of it last Friday. A little bit more on the rationale for the relationship between Pratt & Whitney and Energomash and some of the opportunities that we're currently pursuing and our approach to those opportunities. And finally, a very very brief indication of the status of those programs.

This is an organization chart that shows United Technologies *(Fig. AR-1)*, and what I want to do is point out a few areas because it's going to make some sense when you see the next chart. Within United Technologies we've got Carrier air conditioning, heating, ventilating; Otis elevators and people moving; Hamilton Standard with, as space sees it, life support systems; Sikorsky with helicopters, commercial gas turbine engines, military gas turbine engines; and then a little organization here on the bottom that handles the space propulsion.

This next slide shows the type of involvement that various pieces of the corporation have in Russia *(Fig. AR-2)*. If you remember from the previous chart, Sikorsky with a venture with a helicopter operation in Russia, Hamilton Standard with a company involved in the environmental control systems, Pratt & Whitney involved with three different companies that work with gas turbine engines. In the industrial area, Otis and Carrier with numerous joint ventures in the areas of people moving, air conditioning, heating and that type of operation. Otis alone has well over 10,000 people in Russia at this point in time.

If we get back to that little organization I showed you on the bottom of the United Technologies chart, that's the space propulsion operations. And here we're talking about potential joint ventures with Energomash and other discussions that are going on with Soyuz and operations like Energia.

If we take a look at the space propulsion operations, just to put it in context for you, we have sales of about $500 million a year, approximately 3,000 employees, and we provide both solid and liquid propulsion systems for a lot of systems that many of you are familiar with. Titan, Atlas, the shuttle, both solid boosters and liquid and solid upper stages. One thing that you don't see is our involvement with large liquid

boosters, and that was one of the major reasons we hooked up with Energomash and I'll get to that here.

Back in October of 1992, we signed a joint technology marketing license agreement with Energomash *(Fig. AR-3)*. The features of that agreement include the potential for the transfer of the licensing agreement into a joint venture and Pratt & Whitney's ability to market the NPO Energomash products and technologies in this country. There is one exclusion in that agreement at this time at least, and that exclusion involves the use of an Energomash propulsion system on what is now the Lockheed Martin Atlas vehicle.

A little bit about Energomash *(Fig. AR-4)*. They've been in business since about 1929 under various names. The significance of their operation includes the development of over 50 rocket engines over a period of time which started then and proceeds up to now. They have provided large liquid boosters and some small upper stage engines on virtually every (used to be) Soviet and current Russian launch. And that's where the connection between Pratt & Whitney and Energomash gets strengthened because, as I said before, we have had no experience nor do we produce products of the large liquid booster type.

Their factory, or their primary offices, are located in Khimky, a small town just outside of Moscow. At one point in time, they employed over 9,000 employees. Over the last two or three years that series has dwindled, but we really don't have access to the exact number at this point in time.

If you walk around the exhibit, you'll see various pictures of some of these vehicles. A number of companies are working with their counterparts in Russia to potentially provide access to some of these vehicles. The interesting thing is that Energomash's engines are on all these vehicles, mostly as large boosters, but in the case of the Zenit vehicle, not only do they have the booster, but they also have the upper second-stage engine.

This is a little bit about the Energomash Corporation, and the reason I show this is to show its similarity to the companies that we work for *(Fig. AR-5)*. You'll see production factories, testing areas, various other manufacturing facilities scattered around places that used to be the Soviet Union and are now various countries in that part of the world. If you go down and look inside the Energomash operation again, you see organizations that look like ours (*Fig. AR-6*). The same type of people doing the same type of jobs. So as we began to work with Energomash, it became very apparent that there was a good match between the way things are done in this country that could be done synergistically and in cooperation with them.

One small technical chart (*Fig. AR-7*). This addresses what makes the Energomash engine fleet attractive. What this chart shows along the bottom is a calendar of time and along the upper left a parameter which is very important in rocket propulsion, that being the pressure in the main combustion chamber.

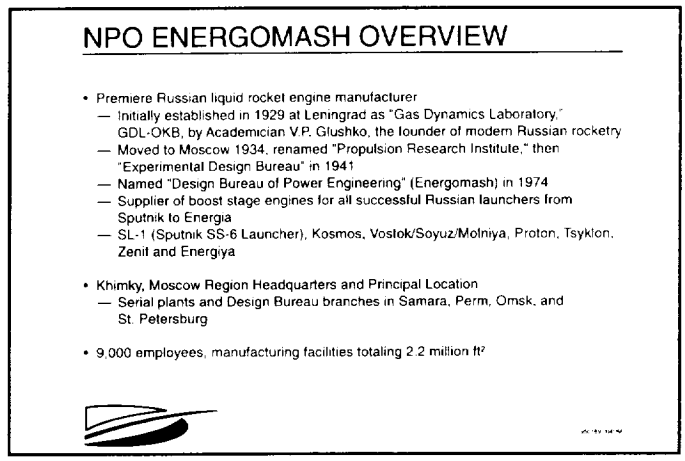

Figure AR-4

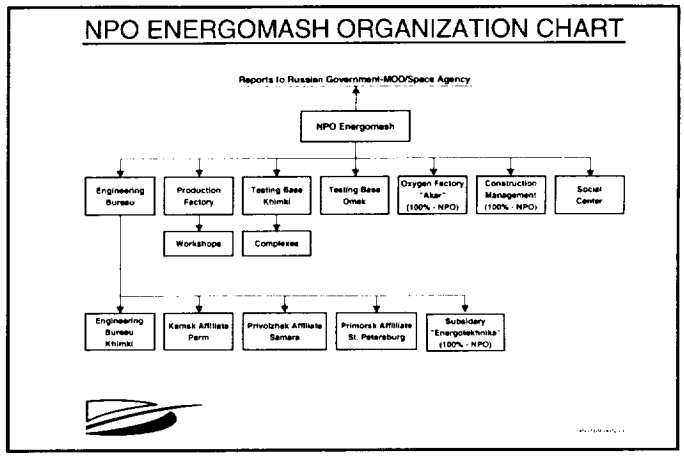

Figure AR-5

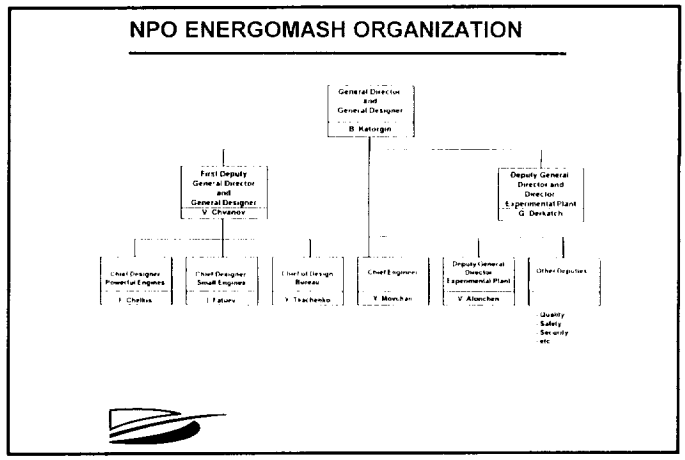

Figure AR-6

The higher the pressure, generally the lower the weight of the engine and thereby the vehicle and the manner of fuel consumption are better performance. For those of you familiar with the gas turbine world, engine pressure ratio there is a very significant item.

I think the thing that's important about this is it shows that over the years there's been a continual investment by the Russians in improving the perfor-

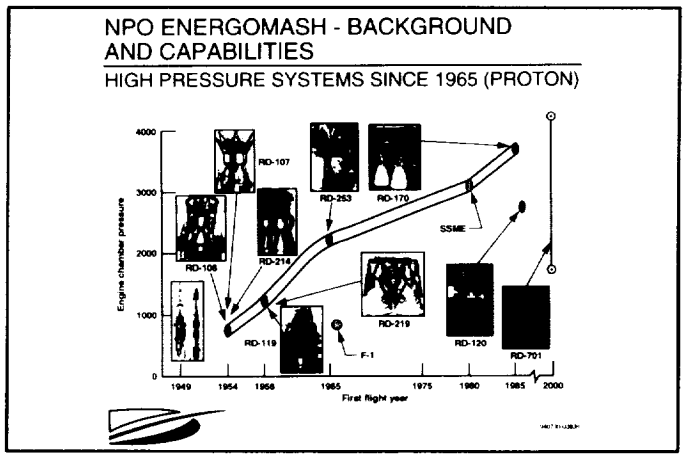

Figure AR-7

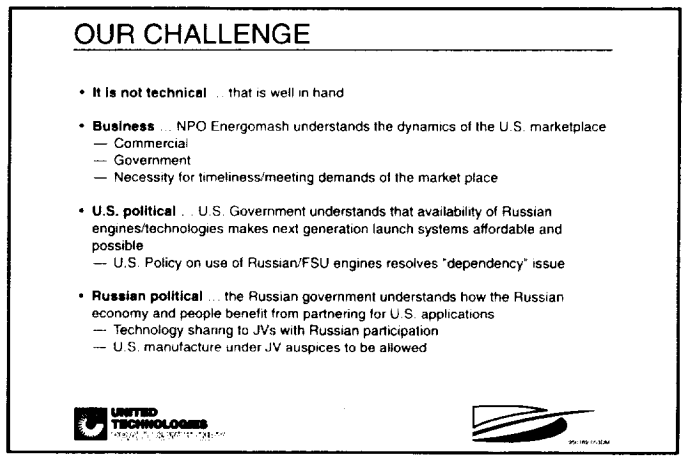

Figure AR-8

mance, the size, and operability of their engines. Even though they've cut back a lot in their launch volume, Energomash continues to do development. And one particular engine, the RD170 is the engine that's used on the booster stage of the Zenit and you can see where it falls in terms of pressure. It's a Lox Kerosene engine. The Lox Kerosene development in this country was stopped 20 years ago, and you can see that the F-1 engine falls down in here. Space shuttle main engine is up around the high pressure line, but that engine burns hydrogen as a propellant, and it's easier to operate at high pressures.

With the potential new starts of the programs that are on the horizon, we feel we can reduce development costs by taking advantage of the work that's been done in Russia, provide perhaps better performance based on their better capability and enhance the competitiveness of the U.S. launch systems around the globe.

So the intent of this is to show that Russians have continued their development, that they've continued to be in production. As a matter of fact, they intend to upgrade that RD170 engine, produce a new model with higher thrust and better performance even next year.

How do we see a synergism and a relationship between what we could obtain from the Russians and bring into this country? Both the upgrade to the current expendable systems and potentially the reusable system have a potential use for these engines. It seems the thinking these days goes toward liquid boosters as seeing perhaps more cost effective in launches, not necessarily cheaper to develop but perhaps more operable. And with more and more launches potentially on the horizon, getting the cost down, getting the development cost and the per unit cost down, is important.

Why did NPO and Pratt & Whitney form this partnership? NPO discussed the potential partnership with many companies in this country. It recognized the long-term corporate commitment on the part of UTC. It recognized the complementary products and the fact that both companies had a good worldwide reputation and the fact that other parts of the corporation were investing.

How do we think this is going to be a benefit within the United States? With the potential new starts of the programs that are on the horizon, we feel we can reduce development costs by taking advantage of the work that's been done in Russia, provide perhaps better performance based on their better capability and enhance the competitiveness of the U.S. launch systems around the globe.

The challenge as we see it is not technical (*Fig. AR-8*). It's tied up in business. Energomash understands what it takes to do business in this country. We understand the challenges in terms of requirements, especially within the government to be able to have engines that we don't depend on Russia for and the ability to do the production in this country. The Russians understand the need, but they understand the fact that they need to make money. We're being told by their minister of defense and their banking institutions that we must form joint ventures, and the joint ventures will be the vehicle for bringing their products into this country.

So that's kind of a brief overview of one company's involvement with another company in Russia, a comparison of the products and capabilities. We see this as a partnership for the future and a capability of enhancing the reliability, operability, and affordability of the systems in this country. Thank you.

MR. RANDOLPH: Thank you very much, Joe. I'd like to move on to our next speaker, Mr. Frank Weaver. He was appointed by President Clinton to be the director of the Office of Commercial Space Trans-

portation. And by the way, I've heard a lot, yesterday there was a lot of talk about commercial practice as if commercial practice was some kind of a magic solution to things. And, of course, as hopefully everyone in this room understands, commercial practice is just plain common sense. And I think hopefully we in the Department of Defense, and I say "we" based on my past experience, understand common sense and can practice that.

Anyway, Frank Weaver is working that commercial space transportation and he is, of course, responsible for promoting the regulation and the growth really of the commercial space transportation activities. He spent a lot of years in the marketing business, marketed over a billion dollars worth of satellites and launch vehicles. He's been published a lot in *Satellite News, Space News*, and *The Washington Post*. He's listed in *Who's Who Among Black Americans*. He's held a lot of positions in industry like in Martin Marietta and General Dynamics and a whole lot of other corporations. He has a bachelor's degree in electrical engineering from Howard University, an MBA in marketing from the University of North Carolina at Chapel Hill, and an honorary doctor of science from Saint Augustine College in Raleigh, North Carolina. He's a fellow in the American Institute of Aeronautics and Astronautics and a member of the National Space Club, and he served as the secretary of the Washington Space Roundtable. Let's welcome Frank Weaver.

MR. WEAVER: Thank you very much for the kind introduction, General Randolph. I'm certainly delighted to be here, and I'm glad that everyone had a chance to stick around. Space is getting to be such a serious topic, I thought maybe I'd lighten it up a little bit because, as I was on my way down on the flight, I picked up the airline magazine which contained an article about some new terminology. Here our topic today is "We can achieve—or we *must* achieve—competitive vision with acquisition reality."

In this age of computerization and Internet, one way that we can change acquisition is to move to the Internet and get rid of a lot of the paperwork. So I read this list of terms and definitions. Words today don't mean the same thing that they used to mean. Today when you say "E-mail," it means you're going to "interface" with someone. If you talk about "net," well, net used to be something that a person would jump over at the end of a tennis match. Now it's a way to jump into the Worldwide Web. Worldwide Web—I just heard that one the other day myself. This magazine article went on to define the Worldwide Web as a conspiracy launched by spiders to take over the planet.

Planet—we're finally getting to what we're all about, space. Right? I think we all understand what space is. But this article defined space as what every relationship, dysfunctional or otherwise, needs more of.

Language is changing. But it started to talk about terms that you and I are faced with every day. Words like "downsizing." What does that mean? It means layoffs, according to this article. What about "rightsizing"? Well, that also means layoffs. What about "restructuring"? That also means layoffs. "Streamlining"? That means layoffs." "Reinventing"? What does that mean? Yes, you caught on. "Outsourcing." Those are preemptive layoffs. Why hire someone who you can contract with? There are no benefits, no perks, no fuss, no muss.

After you go through all that, you finally come to the word "synergy." That's something that I think we all understand. But this article defined synergy as the multiple tasks performed by those left after downsizing, rightsizing, restructuring, streamlining, reinventing, and outsourcing.

In this age of computerization and Internet, one way that we can change acquisition is to move to the Internet and get rid of a lot of the paperwork.

On a more serious note, what does all of that mean? It means if we're going to make things more competitive, we're going to have to reinvent government. We're going to have to restructure things. Does it always mean layoffs? No, not necessarily. But synergy, for those of us who are going to be left after we finish reinventing government, reinventing the corporation, rightsizing and restructuring, means we are going to have the challenge to stay competitive and to create new markets and jobs for those who have been affected by the restructuring of organizations and reinventing the way that we do business. That's the challenge that people like you and me are fortunate to have.

How are we going to reinvent the current acquisition methodologies? There's one premise we're all going to have to adopt. In the current budgetary environment, government is unlikely to fully fund the costs of developing the next generation of launch systems. When President Clinton signed the National Space Transportation Policy, he directed the secretaries of Transportation and Commerce, (and that kind of works its way down to my office in some miraculous way), to identify and promote innovative arrangements between the U.S. government and the private sector to develop new or improved launch systems and infrastructure.

Well, we've got our task cut out for us, because if we're going to do something different, we're really going to have to reinvent something. We can't do things the way we used to do them. We're going to have to come up with some new kind of partnership, and that's one of the things I'm tasked with. I scratch

my head over this task every day. But before trying to figure it out, I thought maybe we should at least talk about some of the recent developments and the new prospects that are on the horizon.

DoT is restructuring. What is that going to mean? Secretary Peña has proposed shifting my office, the Office of Commercial Space Transportation, from its current location in the Office of the Secretary of Transportation into the Federal Aviation Administration. But in this case, restructuring our office does not mean layoffs. Fortunately, Secretary Peña has recognized that this industry is growing, and over the past couple of years he's allowed our office to enjoy some modest increases, both in terms of budget and in terms of the number of people. So in this case, restructuring does not mean layoffs.

In the current budgetary environment, government is unlikely to fully fund the costs of developing the next generation of launch systems.

I see some natural synergy in the move of our office into the FAA. But the synergy really comes because we're going to position the Department of Transportation for the 21st century. If the FAA today regulates and certifies aircraft and airports, in the future the FAA, through my office, will be regulating and certifying spacecrafts and spaceports.

I want to let you know that FAA Administrator David Hinson and I are both space enthusiasts. I view this move with great anticipation, and I look forward to this being a real positive step for my office.

Another recent development. With NASA having made awards to companies to develop the reusable launch vehicle, my office is going to be involved in the certification of this new launch system. That means that we're going to have to work with the companies that have received the awards while they're in the design phase, to try to do it right before they ever get the hardware built. We want to make sure that we design safety in, and make sure that we don't overregulate, so we can also get the cost down.

We also have international space launch agreements. We just signed a new one with China. Now Russia has sent in a request for some more consultations and, just recently, we've gotten notice that Ukraine would like to begin consultations to develop a trade launch agreement with them. We have commercial spaceports that are developing in Florida, California, New Mexico, Alaska, and Virginia.

This week was historic because the first Leo constellations began deployment with the successful launch on Orbital Science's Pegasus rocket of the first two Orbcom satellites. This is really an exciting time to be in this business. We're seeing new markets develop. So this is how we're going to get this synergy to get new markets and get those people who have been restructured or reinvented out of jobs employed again.

This year we're also going to witness the first launch of Lockheed's launch vehicle and, we hope, Kistler's reusable launch vehicle demonstration. We're going to see in the very near term the entry of the new Ariane-5 launch vehicle, aren't we, Doug? We're also potentially going to see the entry of the Ukraine Zenit rocket, aren't we, Jim? So this is an exciting time for us to witness new entries into the marketplace, but it's also going to create some new issues.

Some of these issues I don't have the answers for. I only want to throw them out to you today so that you can help me develop the kind of policy and strategy that is going to help our industry become more competitive.

What's going to be the effect on the U.S. launch vehicle manufacturing base of U.S. companies marketing foreign launch vehicles? To reduce the costs of access to space in the short term, maybe foreign launch vehicles should be proposed. But in the long term, what about a reusable launch vehicle? Isn't that the most cost effective solution? If it is, how are we going to finance it? What about these space launch trade agreements? What are we going to do with them?

What are some of the options that are around to finance new launch systems? There is one that I read about, an article in last week's *Washington Post*. I call it the Boeing 777 model. Jim, you might want to explore this a little bit more, but the way that I read it, the Boeing Company needed to reinvent itself for the 21st century in terms of how it finances, designs, tests and markets its products. It also formed multinational consortiums to spread the risk and to diversify and attract investment. And it also got its investors to order the planes. Maybe if this model worked to develop a 777, maybe it can be used to develop new launch vehicles.

What about the Ariane model? You didn't think I was going to mention that, did you, Doug? The Ariane model works for them. They got a consortium of European governments and their respective aerospace companies to fund the development of launch vehicles. Hmmm, sounds familiar, doesn't it? Maybe we should think about that. What about the prospect for a new federal for-profit launch services corporation that provides space launch services to the federal government and other domestic and foreign customers—a Comsat-like corporation?

There are a lot of models that are out there that have worked. Shouldn't we start thinking about how we can apply those to developing new launch systems? I have a blank sheet of paper, a lot of questions, and there are a lot of issues out there. During the question-and-answer period, I hope you can help me put some words on this paper and give some thought

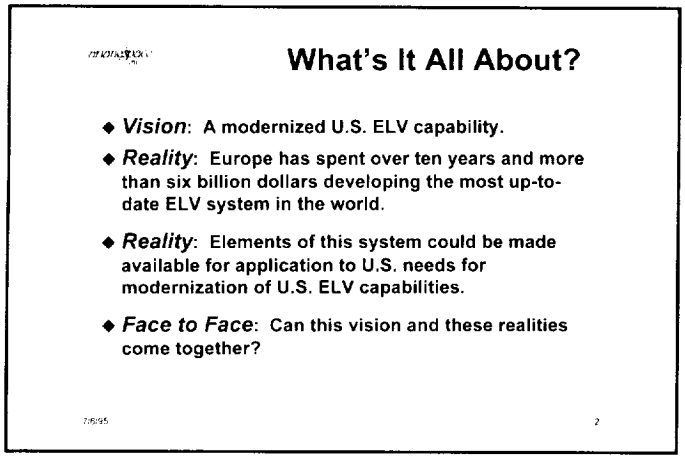

Figure AR-9

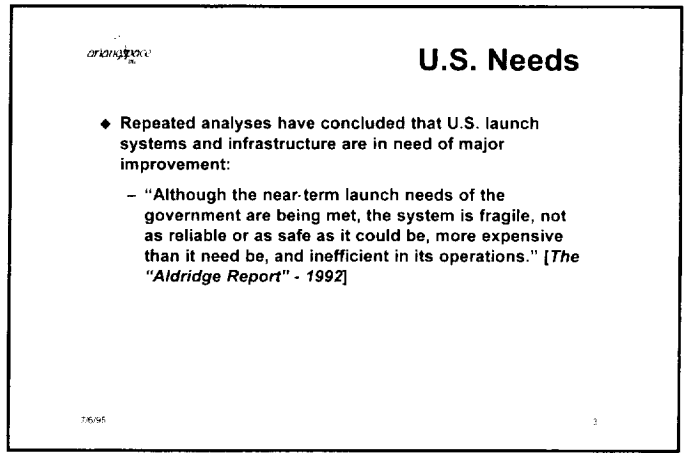

Figure AR-10

to how we're going to develop a strategy to make our launch systems internationally competitive and reduce the cost of access to space. I look forward to your questions . . . and your answers. Thank you.

MR. RANDOLPH: Thanks a lot, Frank. It's always a great pleasure to interface with you—or some of those other words that you used.

But now folks, let's hear from Doug Heydon. He's the president of Arianespace. Prior to that he was the executive vice president and he's had a lot of great assignments in our space business: director of marketing at General Dynamics for a number of years, worked for a little company called TRW at one time, and was involved in lots of programs that I had a little something to do with like the VELA program way back in the '60s and the FleetSatCom program in the '70s and the Atlas Centaur and the Shuttle Centaur program in the '80s.

Doug has a bachelor of aeronautic engineering from Renselear Polytech and a master's degree from Stanford University. He served as an electronic technician in the Navy, and we won't hold that against him because he actually did some research and development work for the United States Air Force as part of the Air Force Reserve. Doug . . . let's welcome him, please.

MR. HEYDON: Thank you, General Randolph. There's been some effort made to tie people's comments to the titles of the panels or the theme of the meeting. I was originally assigned to a different panel, the one tomorrow afternoon entitled, "The world is into space." I think maybe Brian Dailey, being the moderator, said, "Throw him off there," so now I'm on Randy's panel, "We Can Achieve Competitive Vision with Acquisition Reality." I don't quite know how to deal with that, so I'm just going to stick with the main title, which is "Vision and Reality: Face to Face" because I think there's some interesting things we can say about that.

Some of you are probably old enough to remember a television show in the black-and-white era a generation ago called, *Have Gun Will Travel*. As I recall, Richard Boone was the lead actor and he wore a black hat, but he was a good guy in spite of that. He had a business card he handed out that said, "Have Gun Will Travel—Wire Paladin, San Francisco." It was a pretty good show for its era. It gave me an idea for the theme here, so let's see if I can get the next chart up and we'll see what we can do with that *(Fig. AR-9)*.

The idea of vision and reality is something that, I think, leads to some interesting conversational gambits. First of all, it's pretty clear from what many people have said here that the vision of a great many of the people in the U.S. is of a modernized U.S. ELV capability. Some of the realities that we can deal with, and that I'm personally acquainted with, are the fact that Europe, through the European Space Agency, has spent over 10 years and well over $6 billion in developing a very modern system that Frank referred to, the Ariane 5. Another reality, which isn't as obvious to many people, is that elements of this system could easily be made available for application to some U.S. needs for modernizationing capability.

So the question is does this vision and do these realities come together? There have been several analyses made of the difficulties over the years that have faced U.S. launch capabilities. I've just put up a bunch of them here to refresh your memories. These are only some of the more recent ones *(Fig. AR-10)*. This is from the Aldridge Report in 1992.

Next one please *(Fig. AR-11)*. The Congressional Staff so called Space Launch Oversight Trip Report in '93. The House Armed Services Committee Report just last year. These all gave varying views of the nature of the difficulty in this country.

Next one please *(Fig. AR-12)*. I don't think the essence of those statements can seriously be questioned and, more recently of course, there have been a couple of equally famous studies and reviews, the Moorman Panel early last year, and late last year the Foreign Launch Systems Comparison Study that was

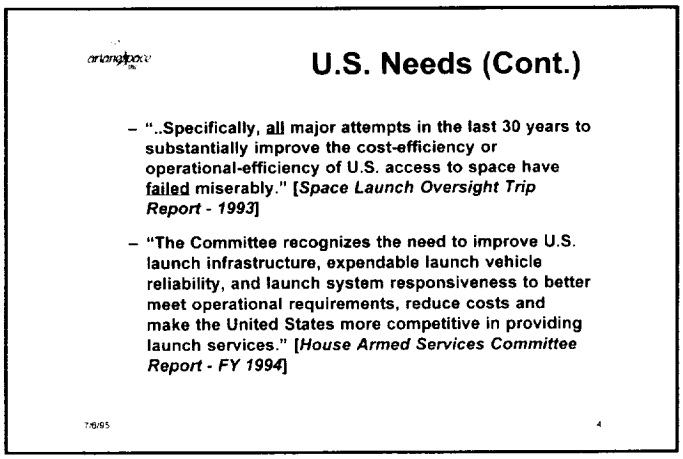

Figure AR-11

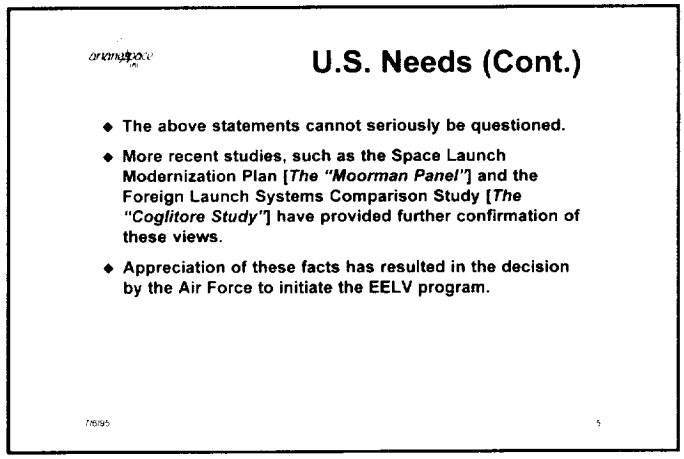

Figure AR-12

run under the aegis of Seb Coglitore. They provided some further amplification, I think, of these views. And I think those were the major elements that led to the appreciation of the need for the EELV program.

Our view is that Ariane 5, or some derivative of it, built largely or entirely here in the U.S. and launched from modernized facilities from U.S. soil could address many of these concerns in the reports just cited and could avoid some of the pitfalls that have been encountered in some previous efforts. Combining much of this already developed technology on a system level with the best of U.S. systems and subsystems could provide both lower risk and certainly a more cost-effective approach to meeting some of the payload requirements.

It's pretty clear that the government has determined that it can't afford the development of new "clean sheet" ELV. Price estimates vary, but the low number is $5 billion and numbers of $10 billion have been thrown about on many occasions. So, under the current anticipated fiscal constraints, that's too big a bullet to bite.

It's possible that Ariane 5, in the manner that I've described, could assist the U.S. in obtaining some modernization. And the fact that $6 billion, and that number is a little rubbery because it depends on how you look at the exchange rate which has changed rather dramatically over the last 10 years, but that's a fair estimate. Most of the results of that investment could be made available to the U.S. for relatively modest license fees.

Arrangements for production and operation in the U.S. without very large capital outlays inherent to a new system such as was discussed in the evolving ALS/NLS/Spacelifter era would approach a much higher level of fiscal acceptability. And the funding requirements for the production facilities would certainly be below new start levels because design and completion of them have already been executed at least once in Europe. Another way that that process could be fine tuned is through the judicious timing of production transfer in the U.S., which would allow the capital investment to be adjusted as a function of time.

Ariane 5 is a clean sheet design, and it is being optimized to provide both inherently very high reliability as well as lower cost per unit weight to orbit. And I think it's fair to say that, taken with the infrastructure, the whole system if you will, is true state-of-the-art technology. They're in place, they're committed to continuous long-term production. We plan to sign the first production lot contracts for 14 Ariane 5s for flights three through 16 about the time of the Air Show in Paris in a couple of months. The environment is fairly stable, and the continuation of that production is reasonably well assured.

I don't think that the reliability of supply in any sense would be an issue since the choice could be made to produce either here in the U.S. or for some common elements to continue to procure from Europe. So it's possible that one or more variants of Ariane 5 manufactured and launched in the U.S. could also fulfill the understandable requirement for assured access to space. This is more than a buzz word, and we recognize this is something that needs to be taken into account while still maintaining some affordable cost targets. And equally importantly, there is no evidence that we can see that would cause this proposed approach to bend any laws, regulations, or executive orders that exist today.

I think there are some significant cost benefits potentially possible by considering an approach of this type *(Fig. AR-13)*. The medium or Atlas class payloads could be launched either on a downsized Ariane 5 derivative or in a dual mode spreading the fixed cost over two missions, which we routinely do today in the commercial Arianespace practice with the Ariane 4. The heavier class payloads, we believe, could be launched for a cost significantly below those of the Titan IV vehicle. And there are already a limited number of Ariane 5 launches planned in support of the international space station. With U.S. involvement, these could be expanded to replace some of the more costly shuttle missions.

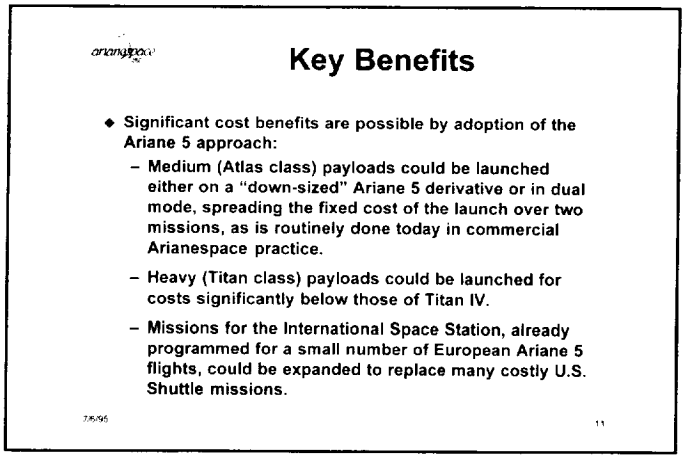

Figure AR-13

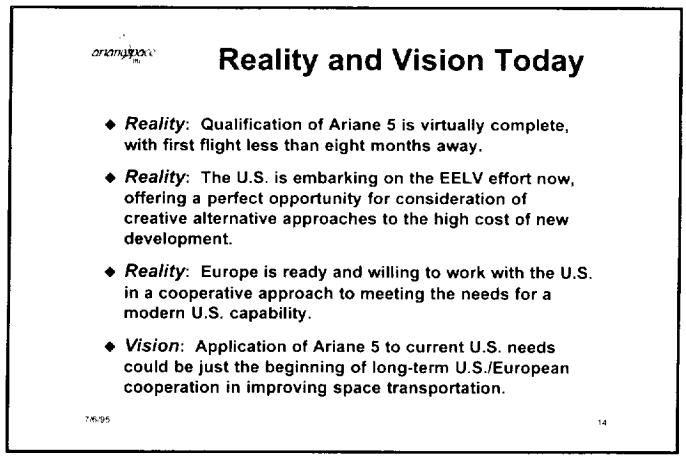

Figure AR-14

There are some other tangible and intangible benefits, too, that I think need to be taken into account. Having redundant systems in two different parts of the western world would create a true mutual backup capability, I think for the first time in this business. That is, where nearly identical systems were operating under completely different sets of circumstances. It think there's clearly a low level of uncertainty concerning availability of the service, and the political and financial risk is moderate and discernible.

Another benefit that I think would flow both ways would be that any performance or process improvements on either side could benefit both, and improve the overall western competitiveness. U.S. hardware upgrades, for example, mirroring the development investment by Europe, could be implemented at no development cost to Europe and reverse the original process as I've described it. Sharing the development costs in this manner could result in some future high tech systems which neither the U.S. nor Europe can afford on their own.

So this brings us to the question of reality and vision today *(Fig. AR-14)*. One of the realities is that the qualification of Ariane 5 is virtually complete, the first flight is less than eight months away scheduled for the end of November of this year. Another reality, I think, is that the U.S. is embarking on the EELV effort now. My understanding is that the RFP is due out in about a month. That seems to me to offer a very good opportunity for consideration of some creative alternative approaches to the high cost of new development.

Third reality: Europe is ready and willing to work with the U.S. in a cooperative approach to meeting the needs for a modern U.S. capability. So the vision that I have is the application of Ariane 5 to current U.S. needs as just possibly the beginning of a long-term U.S./European cooperation in improved space transportation. Thanks very much.

MR. RANDOLPH: Thanks a lot, Doug. There are some good questions, and I'm looking forward to hearing the answers at the end of the session.

Last but not least, folks, is Jim Noblitt, vice president and general manager of the Boeing Defense and Space Group. Jim leads the Boeing work in the prime contract for NASA and the Air Force in the inertia upper stage booster program. He does research and development programs for the Ballistic Missile Defense Organization. He is responsible for production of the U.S. Army's Avenger Air Defense System. In the past he has done a lot of work in the engineering business on B-47s and B-52s and work on the Apollo program, directed the design and proposal efforts on Schram and air launch cruise missiles, and did a little work in the air launch anti-satellite system (which I had a little bit to do with).

Jim is an aeronautical engineer with a degree from Purdue University. He is a member of the American Aeronautics and Astronautics and the National Space Society. Please folks, let's welcome Jim Noblitt.

MR. NOBLITT: Thank you, General Randolph. It's a pleasure to be here today. When anyone talks about acquisition reality the thing that flashes into my mind is the International Space Station program. Perhaps that's because I've spent a lot of time thinking about the program the last few years. But more importantly it's because the program is pioneering basic changes in the way NASA does business. And these changes are driven by economic and political reality.

The first of these changes is the new way of doing business. Things like consolidating the NASA program office at Johnson, having a single prime contractor, the use of Integrated Product Teams, streamlined processes, and a host of other things. Station is the pathfinder for how NASA programs will be managed in the future. A key element in Dan Goldin's initiative to reinvent NASA.

The second change is the international partnership that is building the Station and particularly Russian involvement. The Space Station is the largest international scientific project ever undertaken. In fact, the Station is so large that it is difficult for a single coun-

try to afford. International cooperation makes real sense.

The Russian involvement is providing an extraordinary opportunity for the East and West to work together. To put aside our past animosities and join forces on a common effort that will benefit the entire planet.

But before I talk about that, let me bring you up to date on some of last year's major events.

- First, after months of detail work, the prime contract has finally been definitized. That's important because it means that we've agreed with NASA on a detailed statement of work, a schedule and a cost. We have a firm plan of what's going to be done. It's a tough and challenging plan, but it's doable. And the entire team is fully committed to its successful execution.

The Space Station is the largest international scientific project ever undertaken. In fact, the Station is so large that it is difficult for a single country to afford. International cooperation makes real sense.

- Second is the rapid maturing of the design. Last week in Houston, we held an Incremental Design Review where the entire international team went over the configuration with a fine tooth comb. It really drove home to me how far along we are in the process and how most earlier concerns have been resolved—things like EVA time and debris protection.
- And finally, we're building real hardware, not just paper. To illustrate how well we are doing, let me show you a photo and some data.

Node #2

This is a major piece of real hardware—Node #2—coming out of the welding fixture in Huntsville last week. It's 18 feet long, 14 feet in diameter, and weighs 5,000 pounds.

It is actually a protoflight unit. Its first use will be as a structural test article to verify the structural integrity of the design. Later, it'll be refurbished as Node #2 and will fly in 1999. In the photo you can see parts of Node #1 on the floor. It will complete welding this June and fly in 1997 as the first U.S. element.

With more time I could have bored you to death with hundreds of hardware photos from all the contractors.

Hardware Production Curve

Instead, I'll show a chart that is used as an overall metric. It shows that over 30,000 pounds of hardware have already been completed. It also shows that when fully operational there will be over 600,000 pounds of U.S. hardware in orbit. With the international elements included, this number grows to 950,000 pounds—slightly more than the maximum gross weight of a fully loaded 747 at take-off.

But more important, it shows that we are somewhat ahead of schedule today. And we are on-budget today. We take a lot of pride in these two facts. And we are committed to staying on-cost and on-schedule.

Space Station

Now let me turn to what I believe is the single most important factor in making this rather bold commitment come true. And that's teamwork. In the past there has often been an adversarial relationship between the customer and the contractors. There are reasons for that, but it's proven to be a pretty inefficient and expensive way to do business. It leads to duplication, micro management, and unnecessary paperwork. It slows the decision-making process and stretches out the schedule.

We've eliminated much of that on the Space Station. We are using integrated product teams where everyone is working together for a common set of objectives. This includes personnel from NASA, Boeing, Rockwell, McDonnell Douglas, the subcontractors, and the international partners. We are dedicated to operating as a single unit.

In this environment the teams are delegated a great deal of authority. They control almost every aspect of product design and production. At the same time, they must accept ownership for the quality, cost, and schedule of their product. With empowerment goes responsibility and accountability.

Interwoven in the team effort are good management practices. Things like planning, cost and schedule control, technical performance management, problem identification, tracking, and a host of other techniques. Strong program management discipline is just as important and necessary today as ever.

The great part is, it's really working. The teams are stepping up to the ownership challenge. They're making decisions faster, at lower organizational levels, and with less paperwork. And I'm convinced the decisions are just as good, or better, than those of the past. Things are truly getting done faster, cheaper, and better.

ISSA Elements

The other major aspect of Space Station I want to discuss is the international partnership. While the United States has lead responsibility, the Station Program is truly an international undertaking. The Europeans, Japanese, and Canadians have been involved from very early on and remain full and active participants.

But what's new and very exciting this year is the growing level of Russian participation. I view it in three parts.

MIR in Orbit from Shuttle

The Phase 1 Shuttle-MIR flights are presently underway. In this first phase the Station team is primarily an observer and a beneficiary. But what we see is very exciting. The recent Shuttle rendezvous with MIR was tremendous. It provided a lot of important data on joint operations.

The slide on the screen is MIR as viewed from the Shuttle. At this very moment Norm Thagard is on board MIR. He's getting first-hand experience of its operations as well as conducting some high value experiments. And there is a lot more to come.

While in Moscow in late February, I had a chance to see the SPECTR module that will fly to MIR in May and the PIRODA module that will fly in November. SPECTR was just being loaded onto a rail car for shipment to Biakonour. While there have been a few schedule problems, I'm told it will be on orbit and ready to support the Shuttle-MIR mission in June.

The missions I've mentioned and the ones to follow are allowing us to conduct experiments, check out equipment, and verify operational procedures to be used on Station. They are the first steps in our cooperative efforts and they are going very well.

We are using integrated product teams where everyone is working together for a common set of objectives. This includes personnel from NASA, Boeing, Rockwell, McDonnell Douglas, the subcontractors, and the international partners. We are dedicated to operating as a single unit.

At the same time the design of the International Space Station is being finalized. The Russians, as well as the other international partners, are actively involved in this process. They have a wealth of data and experience that is proving extremely valuable. At last week's Interim Design Review, they presented a substantial amount of data and made excellent contributions.

The third area is the Functional Energy Block or FEB that the U.S. is buying from Russia. The FEB is being procured by Lockheed from Khrunichev under a subcontract from Boeing. While in Moscow recently, I visited Khrunichev. I'm pleased to report the FEB design is progressing well, with a Critical Design Review to be held in two weeks.

I'm absolutely convinced that this international collaboration is paying off. The station we are building will be a better station because of the partnership. It'll be a better station than any one country could have done alone.

I like this photo (not available) because to me it's symbolic. It shows two old adversaries coming together to work on a common dream.

ISSA at PMC

This final slide shows the International Space Station as it will exist in 2002 after assembly is complete. Our vision for Space Station is rapidly becoming reality. I believe that the sort of teamwork taking place between companies and countries on Station can serve as a model for future large space ventures. Teamwork is essential if we are going to establish a base on the moon or fly a manned mission to it. It just makes good sense to work together; to share the expenses and the benefits. Together we can accomplish much more, much faster, than we can individually. Working together, our dreams might just be affordable. Thank you.

Teamwork is essential if we are going to establish a base on the moon or fly a manned mission to it. It just makes good sense to work together; to share the expenses and the benefits.

MR. RANDOLPH: Thanks a lot, Jim. Well, I'm neither a news reporter nor a lawyer, but I really want to thank my panel members for staying right on schedule, and you obviously triggered a lot of interest because there are tons of questions. Unfortunately, we're not going to be able to get to all of them.

Q&A

MR. RANDOLPH: I'll start out, Brenda, surprisingly enough, with one for you. NASA's Lewis and Clarke program delegated acquisition responsibility and oversight for launch services to their contractors, permitting release of two- to three-page RFPs, three- to four-page Commercial Fixed Price proposals, and signed contracts about 30 days later. Is there hope that this approach will be embraced more widely throughout government agencies?

DR. FORMAN: I'd say just let us pray. I don't know what else I can say, just, everybody pray.

MR. RANDOLPH: This one is for Joe. Do you think that the EPA would allow the firing of a Lox Kerosene engine? It is said that they would never allow an F-1 firing now.

MR. ZIMONIS: I guess the answer to that is, it depends on what state you might be interested in firing it. The Russians fire that engine in a little town just outside of Khimky very frequently. In fact, it's a 1.7

or 1.8 million pound thrust engine fired in an indoor test stand. The exhaust is cleaned up and it's silenced. There are ways of doing it. We discussed the possibility at one time of firing an engine of that size at Marshall Space Flight Center and came to the conclusion that the local environmental laws would make it very difficult. So I guess the answer to the question is I'm not sure. But I believe that if it became significant to this country to fire an engine of that type somewhere, I believe we could work out something.

MR. RANDOLPH: Thanks. Frank, there is a vast supply of tax paid ICBMs and SLBMs that can provide cheap access to space for many of the light sats that Dr. Teller proposes. Why must a taxpayer pay yet again for small launchers while these systems are in stockpile? Is current policy justified regarding these surplus systems?

Developing a reusable launch system is probably going to be the key to getting the cost down to a point where it is feasible for individuals to afford to fly in space.

MR. WEAVER: Well, the current policy is stated in our National Space Transportation Policy that these assets should not have an adverse impact on the commercial launch industry. And only under special circumstances could they be used. That was a well thought out policy that tried to listen to all of the various entities involved in this industry. At the present time, that is the policy.

MR. RANDOLPH: Doug, in your opinion, why has Arianespace succeeded with a new launch vehicle while NASA and the Air Force have not?

MR. HEYDON: It should be said to be correct that Arianespace has not yet succeeded with a new launch vehicle. The development is being sponsored and paid for by the European Space Agency. Arianespace will take over its commercial operation after the second demonstration flight. I think the simple answer to that very complex question is that the 13 member states of the European Space Agency have made an extended and continuing commitment to improve space transportation, and it's very similar to the kind of commitment that Mr. Morgan mentioned this morning in connection with EUMETSAT. It is interesting, and to some people surprising, that the 13 member states have provided not only the initial commitment but the ongoing commitment to develop and fund these systems.

I think that that's the first step. The second step in terms of success, of course, is using the system in a commercially friendly way, and that's what we've tried to do with the Arianespace model.

MR. RANDOLPH: Jim, do you see any opportunity for making substantial change to the Defense Acquisition System from the "bottom up"? Is not that where a lot of the system costs are driven?

MR. NOBLITT: Candidly, I don't think you've got much chance of a bottom up strategy working. I think a bottom up can do a lot of things to help and make things better, but if you want to make dramatic changes, you're going to have to have a top down drive because you're going to have to turn over some ways of doing business, some regulations, some rice bowls that exist. I don't think you can do that from the bottom. I believe you have to start at the top.

MR. RANDOLPH: Yeah. Frank, when will the first U.S. private space tourists fly into space? Is your office prepared to accommodate this?

MR. WEAVER: My office is certainly prepared to accommodate it. I believe the reusable launch vehicle is probably going to be the best prospect, and David Hinson, the current FAA administrator, has already told me he wants to be the first passenger. Developing a reusable launch system is probably going to be the key to getting the cost down to a point where it is feasible for individuals to afford to fly in space. I think that these new technologies, assuming that they can be proven and developed, will certainly make that possible. When? Well, that's going to depend on the amount of money we have, and whether we run into any snags along the way in developing these technologies. But yes, my office will be involved. We're going to start now working with the companies that are designing these reusable launch systems to try to certify the vehicle. Hopefully this is going to happen in my lifetime.

MR. RANDOLPH: Brenda, let's try this one. FFRDCs, Federally Funded Research and Development Centers, have played an important role in the military space acquisition and technical oversight business for many decades with an impressive record of success. Given the increasingly shrinking dollars available for space and defense, do you see the preservation and continuation of these centers as a wise investment, and perhaps even more essential today than in the future?

DR. FORMAN: We've got some very difficult questions coming in from the audience. This enters the whole area of laboratory and base downsizing and the whole area of government institutions involved in science and tech and engineering. It's this very, very difficult conflict between the need to maintain skills, core capabilities, and industrial and technical base, and the problem of a shrinking budget that is available to

support these various institutions. And so there are some agonizing choices involved of how much talent can you afford to keep when it's very difficult to point to what the threat is that that talent focused on countering. We need to maintain these skills. The problem is, how do we afford them?

The FFRDCs are only one instance of the problems that we see hitting in base closure actions, in the whole question of the lab reorganizations and consolidations. They're caught up in the same political maelstrom. And how it all comes out, I don't know. Whatever it is, the pain will be great. And one of these days we will probably discover that somehow or another we saved some of the right skills and somehow or other we've lost some of the skills we needed. The trouble is it's almost impossible to predict from here which is which. I guess we'll find it when the next balloon goes up, sorry to say.

MR. RANDOLPH: O.K., thank you. This one's for Doug. Please compare the dollars per pound of an Ariane-5 with existing U.S. launch vehicles.

MR. HEYDON: I don't have all of the numbers directly in my head. I do know that there's a very frequently reproduced chart that shows the evolution of dollars per pound—I prefer kilograms—to orbit and the most recent place I've seen it is a report I happen to have in my room. Whoever asked the question, if he approaches me afterwards, I'll be happy to take a business card and send him a copy of that chart. It's appeared in a whole bunch of government reports.

MR. RANDOLPH: With such a splendid marketing pitch on Ariane 5, will Arianespace submit a proposal to the EELV RFP?

MR. HEYDON: Arianespace does not plan to submit a prime proposal for EELV, but we hope that the ideas presented here may result in our participation with one of the major U.S. bidders. [Note: After submittal of the EELV proposals, it was announced in early July by Alliant Techsystems that Arianespace had been included as a member of their team for the EELV proposals.]

MR. RANDOLPH: Is it true that the absolute cost of a ride on Ariane 5 is more expensive than Ariane 4? Can we assume that the cost of a new launch vehicle may not reduce the ride costs?

MR. HEYDON: As a matter of fact, our policy during the transition period when both Ariane 4 and Ariane 5 will be operating is to charge the same price irrespective of which vehicle is used. After the initial start-up phase of Ariane 5 operations, approximately by the end of the decade, we expect the operational costs of the Ariane 5 to be at or below those of Ariane 4, for a significantly higher payload capability. In other words, the cost of a ride for a given size and mass of satellite is expected to come down. We therefore think that the new vehicle (Ariane 5) *will* lower the ride costs and provide much higher reliability in the bargain.

MR. RANDOLPH: Why on earth would Arianespace want to help put the U.S. into a competitive position with Ariane 5 built in Europe? Is it meant only to capture the U.S. government market, while allowing European-built Ariane 5 to capture all the commercial business?

Getting launch costs down is more than just a matter of launching more of them. It's doing it not only faster, but more efficiently, than we are currently doing it.

MR. HEYDON: As I said in my presentation, there are obvious benefits to cooperation and the use of already developed technology, with the future prospect of broader cooperation as well going both ways. In the near term, we view this as one of the few practicable ways that Europe can participate, in any way, in the U.S. government launch business—not to capture it, but simply to have some role. There will, of course, be the direct benefits to European industry of working with their U.S. partners and developing relationships, not to mention the licensing fees involved. Last, but by no means least, the possibility of a true mutual backup capability of similar or nearly identical systems has tremendous appeal. We also do not have any realistic expectation of capturing all the commercial business, and we'll be mightily pleased if we can maintain a 50-percent share of this market.

MR. RANDOLPH: How would Ariane 5 cover the launch of smaller satellites that EELV is required to launch?

MR. HEYDON: It wouldn't cover the entire range, just as no other system will either. We expect that Ariane 5 would be particularly applicable to the HLV end of the EELV range, and as I said, to the intermediate class either through dual launches or by a downsized version of the core stage.

MR. RANDOLPH: Current Ariane 5 does not support the heaviest U.S. payloads, is not modular in concept, and has yet to be proven. Why then should the U.S. evolve to a system that would eliminate U.S. launch manufacturing capability *and* require as much evolving as U.S. systems?

MR. HEYDON: I disagree with most of the assertions just made. While it is true that the LEO capability of

Ariane 5 will initially be limited to about 40,000 pounds and GTO (at 7 degrees) to about 15,000 pounds (roughly 8,300 in GSO), upgrades already in work will increase its performance to Titan IV or better before the HLV version of EELV is slated to be needed. The most erroneous twist on what I've presented is the notion that this would in some way eliminate U.S. manufacturing capability. If some of the Ariane 5 concepts and designs are incorporated into EELV and built in the U.S., I fail to see the danger to U.S. capability.

MR. RANDOLPH: O.K., last one, for Frank. Ariane 4 is a very cost-efficient system. Its efficiency is related to the heavy utilization of the launch base. If we launch Titans, Deltas, and Atlases every 21 days, how much cheaper would our launch costs be?

MR. WEAVER: Getting launch costs down is more than just a matter of launching more of them. It's doing it not only faster, but more efficiently, than we are currently doing it. It's more than just the rate and getting the numbers of payloads increased. There have been a lot of studies. I think we know all of the answers. It's just now time to apply everything that we've learned and start doing things differently. That's what this whole panel was about.

MR. RANDOLPH: I want to thank the panel for a superb set of presentations this afternoon.

MR. PAYNE: I'd like to thank the session speakers and especially Randy Randolph for putting together and moderating such an informative and outstanding session.

There's one final event today. That's the reception in the Exhibit Hall. It starts right now. We'd like to thank co-sponsors Westinghouse and Lockheed Martin with the U.S. Space Foundation for sponsoring the event. It will end at 6:30, and, of course, it's in the Colorado Hall as last night's was.

As a final reminder, tomorrow kicks off our second day and begins promptly at 8:30 in the morning. The first session will look at National Security Space Requirements, which will be moderated by General Joseph Ashy. There will be a keynote address by the Honorable Jeffrey Harris.

And remember, as you're over at the Exhibit Hall, to shop at the Space Discovery Store. Thank you, and we'll see you tomorrow morning and also at the Exhibit Hall.

Thank you.

National Security Requirements in Space

Master Moderator: **David L. Payne**
Introductions: **General James E. Hill, USAF (Ret.)**

Session Moderator: **General Joseph W. Ashy, USAF**
CINC NORAD, USSPACECOM and Commander, AFSPACECOM

Speakers:

Jeffrey K. Harris
Director, National Reconnaissance Office and Assistant Secretary of the Air Force for Space

Gil I. Klinger
Acting Deputy Undersecretary of Defense for Space

Admiral Walter J. Davis, Jr., USN
Director for Space & Electronic Warfare (N6), Office of the Chief of Naval Operations

Lt. General Jay Garner, USA
Commander, U.S. Army Space & Strategic Defense Command

Major General Roger G. DeKok, USAF
Director of Plans, AFSPACECOM

MR. PAYNE: Good morning. Welcome to the second day of the United States Space Foundation's 11th National Space Symposium. Today we have another exciting agenda, starting with our national security requirements in space, moderated by General Joseph Ashy, with a keynote address by the Honorable Jeffrey Harris. And at lunch, we will have the Honorable Sheila Widnall, Secretary of the Air Force, and she will address the Symposium. Finally this afternoon's session will feature a look at the global space efforts with a keynote address by NASA Administrator, the Honorable Dan Goldin. This evening we'll cap the day's events with the Space Technology Hall of Fame reception and dinner.

It is now my great honor and pleasure to introduce a leader and a champion of the space industry, the Chairman of the United States Space Foundation, General Jim Hill. Please join me in welcoming General Hill.

GENERAL HILL: Good morning ladies and gentlemen. First, let me thank TRW Space & Electronics Group for loaning us Dave Payne to be the master moderator for this Symposium. He's got a virtually impossible job, which he's done very superbly so far, and I'm sure will continue to do that. We do thank you, Dave, and thank TRW.

This morning it's my great pleasure to introduce a dear friend of mine, General Joe Ashy, to this group. He is the chairman of this panel and will be with you all morning.

Joe Ashy now is three-hatted. He's the Commander in Chief of NORAD, Commander in Chief of the United States Space Command, and the Commander of the Air Force Space Command. Joe began his career as an Air Force officer in 1962, graduating with distinction from Texas A&M University's Reserve Officer Training program. General Ashy has commanded both the U.S. Air Force Tactical Fighting Weapons Center at Nellis Air Force Base and the United States Air Force Air Training Command. Prior to assuming his current position, General Ashy was Commander of NATO's Allied Air Forces Southern Europe and 16th Air Force, where he commanded NATO forces in the Mediterranean area and directed the air operation over Bosnia. General Ashy is a command pilot with more than 3,500 flying hours in fighter and attack aircraft, including 289 combat missions in Vietnam.

With his many decorations including the Distinguished Service Medal and the Silver Star, General Ashy is certainly the most qualified to lead this distinguished panel this morning. It's a great pleasure for me to welcome and introduce General Ashy.

GENERAL ASHY: Thank you, General Hill, and welcome to everyone. It's certainly an honor for me to be able to join you today and this distinguished group here at the table with me. Before I start, I'd like to thank General Hill, Dick MacLeod, and all the people we can't personally recognize who've made this week possible. I know you have been doing this for a long time. This is my first experience with it, and I am extraordinarily impressed. I know you, Dick, and General Hill have a lot of unsung heroes who made

things happen, and I know you would permit me to recognize some people we have at "Pete" Field in U.S. Space Command, NORAD and Air Force Space Command Headquarters who helped. So to all of the unsung people who made things happen, I'd like to express, on behalf of the Foundation, our sincere gratitude.

I think our keynote speaker really requires no introduction, but I'd like to say a few words about him because he's a close personal and professional colleague, and it's great to be teamed up with him. We're really fortunate to have him here today. Jeffrey Harris is the assistant secretary of the Air Force for Space and he's also director of the National Reconnaissance Office. In that regard, he formulates a lot of policy and promulgates it; he does a lot of planning and strategizing. He's had a distinguished career, and I think I'm qualified to say and declare that he's an expert because he is. He's from New York. He graduated from Rochester Institute of Technology. He started in the CIA and knows a lot about that business, specifically intelligence instrumentation, space technologies and reconnaissance. He's advised the director of the CIA in many ways, and he's been very integral in the coordination process, or the interagency process, in Washington D.C.

In a visit the day before yesterday (we have these often and I'm proud of that relationship because it's important), he said something that was important to me and I think important to all of us. He said that he produces products for the war fighter, and at U.S. Space Command and our components we market them. That's a profound statement, and I want you to know, Jeff, I received that message. And I think that it's testament to the relationship between our organizations and the team work that we must have, and that we do have in existence, and I'm very proud of that.

Our next panelist is a very distinguished leader as I think you all know. He's the acting deputy undersecretary of Defense for Space and we are really fortunate to have him join us here today. Gil Klinger has a distinguished career; he received a B.A. from State University of New York at Albany and a master's from JFK School of Government. He's held several positions in the Navy Strategic Systems Office, and he worked at Rand and made significant contributions there. He's held numerous positions in DoD that include the Presidential Management Internship, the assistant for Strategy Forces and Policy, deputy director of Targeting Strategic Forces Policy, director of Strategic Forces Policy, director of Space and Advanced Technology Strategy. As I mentioned, we're very fortunate he could join us today, and I really personally appreciate that. I'm looking forward to his comments. I know that he will bring great insight to what's going on on some very key topics of interest to this group, to include perhaps space organization, acquisition issues, perhaps something on the Joint Space Management Board and other pertinent topics. Gil, welcome.

Our next panelist is Admiral Walt Davis. Walt is the director of Space and Electronic Warfare for the United States Navy. He is originally from North Carolina. He went to Ohio State University and got a "double E" degree and he has had an extraordinary career. He's a Naval aviator and has flown tactical airplanes over 3,500 hours to include two combat tours in Vietnam, principally in F-4s and F-14 Tomcats. He's also a test pilot so I know he's flown a lot of other airplanes. Walt has commanded two carrier battle groups. The first was the Forestall, which supported Desert Storm over northern Iraq, and then later, the America Battle Group. He's got a lot of experience in the policy and force integration business, and we're really fortunate to have him here today.

Lt. General Jay Garner's a side kick. I don't know whether that's good or bad; I think it's good and I hope he agrees. As you know, Jay commands the Army Space and Strategic Defense Command and in that regard, he is the Army's component commander to the United States Space Command. I'm really honored to be teamed up with him.

Let me just divert here a little bit. Jay has a forward headquarters in Colorado Springs, commanded by Colonel Paul Semmens. I imagine he's out there somewhere, but I'd just like to acknowledge him because we have a great working relationship with Paul and his people and they do great work.

In Huntsville, Jay manages the Army's Missile Defense Research and Technology efforts and in that regard, he runs and manages organizations around the world. He's got a lot of irons in the fire, and he knows a lot about it. He's had a distinguished career, graduated from Florida State. He's had two tours in Vietnam, he's had many tours in the Air Defense Artillery business, he's a leader and a warrior. Before he assumed his current job, he was the assistant deputy chief of staff in the Army for Force Development in Washington D.C. and that was a very important job.

Our next, last but not least, panelist is Major General Roger DeKok. He is currently our director of plans at Air Force Space Command. He has a distinguished career, particularly in the Space Operations and Space Policy business. He's from Wisconsin, attended the University of Wisconsin, and later attained a master's degree from the Air Force Institute of Technology. Early in his career, he was in the Space Surveillance business and had assignments around the world. He's been on the Air Staff several times, he's been in the White House as an advisor on space, and he commanded two Space Wings: the first at "Pete" Field and when we activated the Space Wing out at Falcon, he commanded that Wing.

To set the stage, permit me to make a few remarks that perhaps will frame our focus, and our discussions and observations, as we respond to your questions later. I think appropriately our theme, which is "Vision and Reality," will help us to do that. In that re-

gard, I think there are a lot of visions we ought to focus on, by some very key people, very key leaders, and very key organizations. Examples are one which I think Secretary Widnall will perhaps comment on today in her speech, one that she's given us in our Air Force hat but really applies across the spectrum, and that is support to the war fighter. I think my colleagues up here all will agree that this is a No. 1 priority. So that's the vision, support with reliable information to our customers, the warfighters, from space-borne assets. The reality is that I think we do a good job. We are learning; our learning curve is going up rapidly, but we need to do better. And I think we are, with some great contributions from our components.

In testament to that are examples like the Air Force Space Warfare Center and the U.S. Space Command's proposal to the Joint Staff and General Shalikasvili to stand up a Joint Space Warfare Center. We've established and standardized our space support teams and I think they are delivering very good products. We're getting great feedback. I know Jay has his, our other two components have space support teams, and we are also employing them from the Joint Headquarters. So, the vision is to provide reliable, understandable, usable, high-quality support to the warfighters, and the reality is that we're making great progress.

The next example could be affordable launch; that's the vision. Obviously, we need to do better here and that's what the Evolved Expendable Launch Vehicle (EELV) is all about. Talking to our partners in the commercial and civil sectors, I think that we can make great progress here to create a condition whereby our commercial producers, many of whom are in this room, through the competitive process, can provide us high-quality, timely, affordable products to get in space more cheaply. That's what the EELV requirements document is all about. We're making great progress. I would like to express my personal gratitude to our partners in industry, in the commercial sector particularly, for your cooperation in providing us the feedback before we go in final draft on the operational requirements document. I look forward to making great progress here, not only for the country but also for the space business.

The next vision is missile defense. Our vision is to provide an effective, umbrella protection for U.S. personnel, and our allies that are threatened today by the proliferation of missiles in theaters of operation. I know Jay Garner will join me here and he will probably talk about this, but we're making progress here as well. The status from the U.S. Space Command's perspective is that we do a very good job with our current DSP system in providing space-born detection capability. If you haven't read about it, we have made great progress because of the work we have done through our component organizations. I'm talking about the Naval Space Command, the Army Space Command, and the Air Force Space Command, by improving the warning manipulation through digital capabilities that DSP gives us through the Tactical Events System. We can do it better and with more quality. That's the reality. I'm pleased to report to the group that we have finalized the requirements document for SBIR that will eventually replace DSP, and it will have the capability in a very quality way to deliver warning information to our theater commanders for all systems that will have to be contended with.

. . . modern battle space is complicated and dynamic. We must integrate and use effectively space-borne assets to deal in modern battle space.

In summary, modern battle space is complicated and dynamic. We must integrate and use effectively space-borne assets to deal in modern battle space. To keep the advantage, we must control the high ground. To do this effectively, in the cycle of sensing and detecting and feeding back and analyzing and deciding and directing and acting, perhaps shooting, and doing that cycle over and over again, we must do this inside the adversary's cycle. As technology marches on we must realize that it will be available to our adversaries as well. We must keep up with our concepts and our capabilities and our abilities to execute, and that's what this Symposium's all about. And that's what our partnership with the commercial sectors is all about. I look forward to hearing the perspectives of our distinguished speakers and panelists.

Jeff Harris knows a lot about this cycle, particularly the first three steps as I described them and probably the others, specifically detection feedback and analyzing. It's an honor for me to be able to introduce him today.

MR. HARRIS: It's a real pleasure to be here this morning and have the opportunity to address a Symposium like this, because I can look out and see so many of you who have dedicated your professional lives to the betterment of space. The theme for today is "Vision and Reality." It's always a great pleasure to come out to where we can interface with our industrial team. Because it's the industrial team and the leadership of that industrial team that over the years has just made incredible strides in terms of taking the technology that we have developed in the space business and applied it to meet the visions of the future. We don't talk about what we're going to do. We actually go off and do it.

My theme for this morning will be "A Vision of the Future," a vision that combines the needs with the projected availability of technology. I'm lucky because my current responsibilities give me the advantage and the spot where I can help to focus these leading-edge

technologies—technologies that will serve as the basis for cost-effective, mission-effective use of space into the next century. This is something we have done very well in the history of military use of space, but we now have technologies that allow us to do it better, faster, and a whole lot cheaper than we've ever done before. This is just a truly exciting time that we face.

All of a sudden when you think it's safe to go back outside, the garden variety terrorism and just plain nut cases, the saran gas attack in Tokyo's subway system I think is a message to us all that the new world order is anything but orderly.

Space has been an important contributor to our national security effort. Over the last 30 years, the United States has dominated the use of space in support of our military forces and U.S. foreign policy interests. During these three decades, the United States has developed programs to develop unequaled capabilities to provide intelligence, navigation, surveillance, weather, and communications from space. These systems support our warfighters in both peace time and crisis. In the aftermath of the Gulf War, we, our allies, and (particularly), our enemy learned how instrumental these space-based systems were to our success. Even more important, the lessons we learned from the Gulf War. The knowledge-base of experience provides us with real-world examples to further tune and enhance the support that can be made available from these very magical systems that we have all put together.

A better understanding of how we use space will allow us to shift from our Cold War-based strategic emphasis to a regionally focused model. Key technologies will be instrumental to help meet our needs in space systems. These technologies will allow us to address these needs that are ever increasing. Today, the rapid advancement of technology has redefined the term "obsolete." Obsolete used to be years, now it's months; and for many people in the business world, you understand if you snooze, you lose.

Technology moves very quickly. There is a lesson there, even for those of us in government who have not mastered the profit motive and the cold reality of what the profit motive does in the business place. The recognition of obsolescence is pretty important. As a result, the reality of what we do in space is measured in the time it takes to fund, engineer, build, and integrate new capabilities into existing systems.

Our challenge for the future is to move quickly so we are able to incorporate and field the most modern technology quickly. Ted Turner's statement, "Lead, follow, or get the hell out of the way," is sound advice for those of us responsible for implementing the visions we now have for space.

Last year, Admiral Bill Studeman stood before you to discuss the role of space in the new world order. He spoke of the transition in the U.S. intelligence community as we evolve from focusing on the monolithic threat of soviet expansion, the worldwide threat of communism, to policing an explosion of smaller crises around the world. I watch every day with fascination, and with some concern, as the world is being redefined. Events that once occupied the foreign policy back burner are now of increased importance. These events used to be found in the world section of the newspaper. Those events that were there and happening in the world section now occupy the front pages of *The New York Times* and other major newspapers around the country.

The major shift in those events, as they moved from the world section to the front pages, is these societies that were relieved from the iron fist of old regimes; governments that held back the regional struggles, the differences, the ethnic disparities for decades can now erupt and they are erupting with unexpected frequency.

Let's take a look at the last year from a national security focus. Without even stretching, we think back to the events of Somalia, Haiti, Bosnia and all of the former Yugoslavia, Rwanda (a country where many of us had to look in the atlas to figure out where it was), countries in Africa that have been renamed several times since we studied them in civics. Proliferation reared its ugly head in the form of North Korea, one of the most isolated countries in the world, and a very difficult foreign policy and incredibly difficult intelligence challenge. The events in Chechnya and the stability of the Russian government as they sort out some of their internal affairs cause us to pause.

All of a sudden when you think it's safe to go back outside, the garden variety terrorism and just plain nut cases, the saran gas attack in Tokyo's subway system I think is a message to us all that the new world order is anything but orderly.

I was trying to look for some term to put this into something that's of value to the Colorado Rockies and the opportunity for us to spend some time together here in the shadow of the mountains and I immediately thought of Coors Light. I was reading *The New York Times* last Sunday and it had a little contest, for those of you who saw it, that said, "Why don't you name the era that we live in?" The example I liked the best was that history really names the era that you're in, that you really don't have the opportunity to name the series of events that's framing history as it unfolds. But I read past my favorite and found one I thought was applicable to this morning's talk. It was suggesting that perhaps now we have the "Cold War Light" era.

I wasn't sure when I read the headline that I know exactly what that meant. The author who coined the

term put it in pretty good perspective to me as we think about the events moving from the world section of the newspaper to the front page. She described it as "global skirmishes that are morally appalling and complex but lack a clear embodiment of evil like Hitler or communism." No where in that statement did I say they weren't important. They're just a whole lot different in terms of how we think about this new world than we did when we had some of these clearly focusable, more monolithic threats. This may define the paradox of national security in the coming decades.

My conclusion from that, assuming that the U.S. continues to be a world leader, is that this uncertain future demands a global, flexible, and responsive space reconnaissance; space intelligence; and space systems architecture.

As we get to what this future demands of that, let's take a look at the evolution of national security in space. As we establish our vision for the future, let's look back at the history that brought us here. Events of 30 years ago have framed some of the key drivers for military space. Can the experience we've had over the last 30 years help us to define a path into the future? And, is today's plan consistent with tomorrow's reality?

The United States National Security space programs grew out of necessity, a necessity to clearly understand the Soviets military capabilities and our desire as the U.S. to be an active, and I might add winning, participant in the space race. The information demands of the missile gap, the bomber gap, and other related activities could easily be satisfied with the very high technology U2 aircraft. Clearly, short development high-tech applied against a problem. But May of 1960 following the shoot down of Gary Powers, the critical need for intelligence demanded an alternative source.

As President Eisenhower said at the Paris Summit in 1961, "No one wants another Pearl Harbor." This means we must have the knowledge of military forces in preparations around the world, especially those capable of massive and surprise attack. That line in 1961 and that line today says the U.S. and its allies just don't want to be surprised.

If I turn the clock back to May of 1960, and we lost the ability to collect information on the Soviet Union partially with the suspension of overflights by the U2, we are lucky that the country had embarked on a credible space program in response to the launch of Sputnik in 1957. The leaders at the time recognized the importance of space technology and put together an aggressive program. Eisenhower's understanding of the need for space supremacy was a catalyst for the CORONA program and the Apollo manned space program. We started with small teams of dedicated people with a great vision. We experienced a string of problems and, in several cases, disasters, but we built two highly successful programs that started in the '60s.

The Apollo astronauts were the first men to land on the moon, and they focused a series of international events in an international stage in which the players all raced to surpass technological barriers we had never crossed before.

This year the intelligence community began to publicly take credit for its contribution to the Cold War space race with the declassification of the CORONA program by Vice President Al Gore on the 24th of February. For those of you who get *Photogrometric Engineering and Remote Sensing*, the April 1995 issue has on its cover the declassification of some of these early images and an article about the history.

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CORONA, which operated from 1960 to 1972, achieved a number of firsts in space and helped set the standards for the manned space program, again focusing the technologies to solve problems. The first CORONA was launched on 28 February 1959. This is a program where we were postured to launch sometimes two rockets within a two-week period. We could build the rockets faster than we could build the reconnaissance payloads. What we found was an incredible difficulty in engineering all of the different systems together because we were having spectacular successes. The booster would work fine; we would get the payload on the orbit. Everything would go fine, except the film capsule would not eject. We would launch the next one and the rocket wouldn't work. We'd launch the one after that. The rocket would work, the payload would work, but the timing was off and the capsule would come down somewhere over the northern islands of Norway and spawned the popular book *Ice Station Zebra*, where the Russians and the U.S. are fighting over microfilm. Those kinds of thoughts as we slowly become declassified, you'll find add more reality to the story.

And then there was the technology. Because we were operating under a cover of biomedical programs, on one of our missions we had a biomedical package that had some ice on board. We had carefully designed the payload portion to instrument it. We had temperature and humidity and air pressure and all of that. We erected it on top of the rocket and just prior to countdown, the humidity sensors went wild in the payload section. It took a while for the engineers to recognize this was only the mouse that roared on top of the humidity sensors in the launch position underneath the

rocket.

By Discoverer 13, we successfully recovered the first object from space on 12 August 1960, and in the very next mission we had successfully integrated all of the pieces together. On 18 August 1960 we had the first-ever image taken in space and recovered by a capsule. The CORONA vision that allowed this country to anticipate its needs so successfully, that the first image over the Soviet airfield from a space-based reconnaissance system was only 109 days after the suspension of overflight by the U2.

What the National Security space program did was combine the best of the Air Force, the CIA, the Navy and most importantly, our industry partners to get it done and get it done quickly.

How did we get there? Let's look at the component parts: a need, a vision, a leader, resources, and above all else, determination to get the job done. The CORONA pictures guideposts of history will tell the story of the programs success. With the visual confirmation provided by CORONA's imagery, we could track hundreds of military targets in denied areas, understand the Soviet strategic capabilities, track arms sales and activities of Soviet-client states, and ultimately make informed decisions on national security matters, eliminating much of the previous guesswork.

The technology allowed us to improve imaging resolution from eight meters to two meters over the 12 years CORONA operated. It provided the first mapping of the Earth from space. It provided the first stereo optical data from space. And if that wasn't enough, it was the first program to succeed with multiple re-entry vehicles in the first reconnaissance program to fly in excess of 100 missions.

Over 18 months, we will release more than 800,000 images representing the success of the CORONA and her sister programs, ARGON and LANYARD. These images will become available to scientists and historians through the National Archives and the U.S. Geological Survey. For those of you who are anxious to get into this trove of data, we will be releasing about 2.1 million feet of film that is now stored in 39,000 cans of film.

What are the lessons learned from this program, a program built by a small number of people in short deadlines? We learned to empower small groups of people with the latitude to make decisions, and sometimes mistakes. People on a mission. People on a mission to explore all the options to achieve their goal. What the National Security space program did was combine the best of the Air Force, the CIA, the Navy and most importantly, our industry partners to get it done and get it done quickly. Staff oversight was minimal, field managers were delegated authorities unheard of in any other program. Cultural and authoritative barriers were crossed with impunity, all to accomplish an overwhelming mission in utmost secrecy. On the 24th of May this year, we will celebrate the accomplishment of these early space pioneers. The National Space Club and the National Reconnaissance Office are planning a commemoration of these early successes.

From this program and its technology base grew today's security space programs and a myriad of modern technologies that support both civilian and military missions worldwide. These programs formed the genesis of a web of technology that is still growing that includes the Defense Support Program, the Global Positioning System, the Defense Meteorological Satellite Program, DSCS, FleetSatCom, MilStar, Atlas, Delta, Titan, and today's generation of reconnaissance satellites.

These systems have provided to our national policy makers and our warfighters capabilities such as global weather tracking and forecasting, worldwide instant communications, pinpoint navigation anywhere on the globe, threat warning, and near real-time intelligence to users where they need the data to allow them to act quickly.

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From austere and risky beginnings 35 years ago, we've developed the most enviable space information systems. No nation can come close to providing the volume and quality of information we receive from space.

Let's take a few minutes to focus on what's driving the future of space and how we should react. Then the fun part, that of the palm reader, the fortune teller, the carnac—you know, the vision thing. Take an envelope up, put it together and figure out where it is we're going to be 30 or 40 years from now.

I've picked a handful of topics on which to focus. As you probably recognize, there are many factors that will affect our view of space into the 21st century. Hopefully, some of this will spark discussion with the panel to follow. We have assembled an awful lot of space expertise in this room to help us exchange and hear each other's ideas. This forum will be a good way for us to hear our ideas of where we are, and where you think we are going.

First, the needs of our foreign policy have altered the landscape of information processing dramatically. The national security apparatus used to have a primary focus on a single continent. Policy makers today and the folks who support them—our services—demand much more information from more disparate parts of the globe more quickly than ever before. As a result, we have this information explosion, information that is flowing at the multiple terra-byte miles per second.

Terra-byte miles per second is a new unit to describe moving large amounts of information to the users within their timelines—information collected from a variety of sources, processed, fused, analyzed, and delivered on time to ensure its usefulness to the user. In turn, the analysis will be used to assess the situation, have the information available to protect the ability to act and decide what to do. Whatever option, political pressure, economic sanctions or military action, information gives us the critical edge. Information supremacy may well define the U.S. as a superpower in the 21st century. Information dominance in policy, information dominance on the battlefield.

The rapid advancements taking place in the information arena shows that information grows exponentially. It comes a lot faster, it comes in much greater volumes, it comes from longer distances and it requires a much faster response time. The productivity that we're seeing of the modern workforce is directly related to the number of beepers, cellular phones, fax machines that have all been a trick by our supervisors to get us to work 20-22 hours a day. It used to be you hit your car, stop at 7-Eleven, have a cup of coffee, think about what you could do this weekend. Now you're putting your second and your third car phone on hold, going back to the trunk to service your fax machine, driving and typing on your laptop computer because the information is coming in much greater volumes and much longer distances. The days of sending an emissary to Paris to negotiate the deal, traveling by ship with an occasional letter back to the leadership, are long gone.

I wonder how many of you saw a recent issue of *Time*, "Welcome to Cyberspace." Here a major U.S. weekly focuses a whole issue on the electronic information explosion, an explosion that is now considered popular culture instead of the fringe. Now, for computer geeks and technogeeks like myself, this is sort of exciting when you can pick up one of these weekly newspapers and we can actually have this information explosion being a very popular culture and affecting an awful lot of people. The same people who thought microwave ovens were dangerous because we were "nuking" food. Remember grandma with her first microwave oven? She said, "I'm not going to put that in there because you *can't* cook a baked potato that fast." Those same grandmas and grandpas are now signing on to the Internet and they're complaining about their sons and daughters because they're not coming along fast enough. And their sons and daughters are complaining about their sons and daughters because they're coming too fast.

Send your kid off to school, brand new computer, it's about spring break: "Hi mom, I need a new upgrade, I need this...I need that." Showing up in the workplace, those of you who provide information systems to your employees. They come in and they make demands unlike any other new employee of 10 years ago: "What do you mean we don't have this kind of connectivity? What do you mean we don't have this kind of information processing?" Try to buy a GPS receiver during the Gulf War on the commercial market. They were all bought, put in rucksacks and taken with them. The Defense Mapping Agency had a whole bunch of really well-informed customers telling them exactly where every mistake in one of their conographic products were, provided in real time from space. This is great customer feedback.

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Cyberspace—it was coined in the early 1980s by William Gibson, a science fiction writer who was inspired by watching teenagers hunched over video arcades. Gibson defined cyberspace in his stories as a computer-generated landscape of unthinkable complexity with great warehouses and skyscrapers of data. This modern fairy tale of 1980 is now this new way of conducting business.

And the business is changing things rapidly. My brother, a frequent surfer of the cyberspace, remarked to me in an E-Mail how strange it seemed to be sending messages in real-time around the world while he was looking out the window at a horse-drawn cart in Hungary. And he thought that was sort of interesting in terms of the kinds of information explosion that's taken place where some of the countries that are no longer subjected to the environmental conditions that they were under the previous leadership are now able to jump in to the cyberspace explosion very quickly and you can see the difference in how you can get online a whole lot quicker than you can get rid of the horse and buggy.

Thirty-five years ago, how did we connect cyber and space? This coining of the word, I think, was really visionary doing because it saw that space was such an important piece of this revolution. Thirty-five years ago when we began this National Security space business, it was our search for information that built

the foundation of technology for this information age. Space was there in the beginning, and she's just coming into stride now. You've seen nothing yet.

If you think about how quickly technology changes our lives, we forget the little things like what a pain carbon paper was. But we do remember the big things. The Wright brothers flew in 1903. We landed on the moon in 1969. Sixty-six years. What a spectrum of capability we crossed, if that is an extraordinary period. If I use that 66 years as a ruler for high-tech progress, and we're 35 years into it now, only half way there, ladies and gentlemen, hold on to your hats.

The issue of information is how do we translate all of this beneficial environment into something our customer can recognize? Ten years ago our customers were content with waiting for a lengthy analytical report. Communications were conducted by mail or phone. Today, mail isn't fast enough, and a phone call won't do. You want the information before the information is available to be sent. You want it delivered faster and better than anyone. We must set the vision, establish the standards, and focus the technology. We must execute a strategic plan and carefully execute it instead of jumping on the technology train for an unknown destination.

Winning the war in the information age with U.S. forces potentially stretched thin will be possible because we control the critical information. The value of having complete, accurate and timely information will increase exponentially as we move into the 21st century.

Information and information dominance will play a very important role in every conflict in the future, whether big or small. We need to understand the benefits of having a systematic way to use information in our military operations. Now that we are in the information age, the military will derive their tactics in large part from the innovative use of information tools. Information systems will be combined in such a way to create a consistent, seamless, situational awareness where information is available to the war fighter on demand. Space will fit into most facets of these military operations with communications, weather, surveillance, navigation, and reconnaissance. Winning the war in the information age with U.S. forces potentially stretched thin will be possible because we control the critical information. The value of having complete, accurate and timely information will increase exponentially as we move into the 21st century.

Military planners coined the "OODA loop" to explain the process by which information is received, comprehended, evaluated, and acted upon: Observe, Orient, Determine, Act. To make this OODA loop successful, we must have interoperability between our systems and between our systems and our allies. We need to merge formerly separate disciplines, and we have to master what the manufacturing industry has already begun to master, just in time delivery of the right information.

Space provides us the necessary edge to make OODA a reality. By employing the right communications, we can provide the latest weather over a strike target, deliver pinpoint navigation information, pinpoint targets or obtain broad area reconnaissance to characterize the battlefield. Things like unmanned aerial vehicles will supplement space-based assets so the strengths of each allow the military planners to understand what it is they can get and the strength of each of the parts combined together to make an integrated greater whole.

Ten years ago we recognized the component parts of this technology and we delivered these parts as a series of stovepipe systems. Now we recognize the power of integration and crossed to main information sharing. To provide the necessary solutions, we need to press full court and think outside the box. Space systems are only but one part of the cyberspace equation, but how should we, the space community, fit in?

There's nothing new in this next idea. It is one that we all recognize, but it's one that we haven't quite matured to the stage where we can take full advantage of it. We need to focus on an information system that is "demand-pull" in which users select what they need, the acceptable response time, and the frequency of the required data update. The Internet has mastered a piece of this on a small scale. As a user, you can select and download data as you wish, converse with other users, learn from each other, and query the experts when you need help.

Our lives have changed. *CNN, C-Span, USA Today, Worldwide Webs*—all are part of our daily lives. We focus our information needs with new tools for a new age. The National Security information systems need to recognize these tools and our information systems will be a mixture of commercial and government systems. The mixture will allow us to balance cost, performance and, most importantly, assured access to data. The demand-pull concept presupposes a lot about the information by assuming a substantial database of facts which are accurate, enough information to support the needs of the policy makers, the CINCs, the Battalion and the Squadron commanders, a rapid response time, a worldwide dissemination system and a secure communications network. If we don't think this way, and we don't think interoperability, we will never achieve our ability to make decisions inside of our enemies OODA loop equivalent. If we do, we have a tremendous lever arm to stay out in front.

Let's talk about the commercialization of space and how that can be a major driver. The mix of com-

mercial development with government is a tremendous lever arm to help us achieve our vision. Today a multitude of commercial ventures in space are racing to achieve bold new innovations. Venture capitalists are starting up new companies with big new ideas. The international marketplace has recognized the advent of space and will field a variety of systems. The commercialization of space is harvesting technologies that were formerly, exclusively used by the government. The government invested in key technologies and these technologies are now paying off to a much larger variety of users. This is good. This commercialization will give us an opportunity to take advantage, and the advantage is saving money.

As I said earlier, some of our needs can be addressed by leasing or purchasing commercial spacecraft. It will change our thinking from military satellites for communication to satellites for military communications. I think we have crossed that barrier with a flexible, secure worldwide network that allows us to provide our users with tremendous new capabilities. As the government expenditures in space continue to decrease, the commercial space marketplace helps to keep factories open and workers employed. The government will continue to have its unique needs and, therefore, uniquely focused technology programs, but we no longer have to carry as long a portion of the space infrastructure ourselves. The government and industry working together as a team in pursuit of common goals is part of the formula for our future successes in space. To do this, we must have a government policy framework that allows U.S. corporations to compete fairly in the international marketplace. Unfortunately, the government must continue to restrict this marketplace, but this restriction will be agreed to upfront and only when very specific national security objectives are threatened.

Solid cooperation with government and industry will ensure several advantages to our nation and our aerospace industry. Commercial sales of space systems components will keep the necessary industrial base available between military space development and production runs. As satellites last longer and longer, and we make more and more capable satellites, the factories have noticed fewer satellites moving through the factories. We need to resize our production capability and take advantage of the lever arm between balancing the government and the commercial satellite needs.

From a national security standpoint, we cannot stop the proliferation of commercial space systems, nor should we want to. In the area of space reconnaissance, we have established a policy with Presidential Decision Directive 23 on Commercial Remote Sensing. This policy can further our national security goals by allowing U.S. firms which pioneered space-based reconnaissance to compete and compete fairly in the global marketplace. Recent activity by several corporations is indicative of this policy's success.

To keep up with the changing environment, I recommend that we need to change some of our management practices and methods. This is not a new problem, but we need to take on the debilitating effects of supporting an infrastructure that has been left unchecked.

The government and industry working together as a team in pursuit of common goals is part of the formula for our future successes in space.

I'd like to read to you a letter that was sent in August of 1812:

"Gentlemen,

Whilst marching from Portugal to a position which commands the approach to Madrid and the French forces, my officers have been diligently complying with your requests which have been sent by Her Majesty's ships from London to Lisbon and by dispatch rider to headquarters. We have enumerated our saddles, bridles, tents and tent poles and all matter of sundry items for which His Majesty's government holds me accountable. I have dispatched reports of the character, wit and spleen of every officer. Each item and every farthing has been accounted for with two regrettable exceptions for which I beg your indulgence.

Unfortunately, the sum of one shilling and nine pence remains unaccounted for in one infantry battalion's petty cash, and there has been an hideous confusion as to the number of jars of raspberry jam issued to one calvary regiment during a sand storm in western Spain. This reprehensible carelessness may be related to the pressure of circumstances since we are at war with France, a fact which may come a bit of a surprise to you gentlemen at White Hall.

This brings me to my present purpose, which is to request elicitation of my instructions from His Majesty's government so that I may better understand why I am dragging an army over these barren plains. I construe that perforce it must be one or two alternative duties as given below. I shall pursue either one with my best ability, but I cannot do both.

1. To train an army of uniformed British clerks in Spain for the benefit of the accountants and copy boys in London, or perchange

2. To see that the forces of Napoleon are driven out of Spain.

Your most obedient servant, Wellington"

No secret that we need to examine how we do business within DoD in our interface to industry. Lots of ideas, lots of areas to attack, but one thing we all

seem to agree on is we need to make the changes and make the changes now.

I have good news to report. Change is in the wind. We are very fortunate indeed to have Bill Perry, John Deutsch and Paul Kaminski, folks who have been on both sides of the government/industry coin and actually see that the future of DoD acquisition requires changes to be made.

Our dependence on space, given the problems we are facing, requires that we ensure U.S. access to space for commercial and military payloads.

As I continue my thought to you, let me shift gears. It's difficult to give a talk to as prestigious a space group like this without discussing the "L" word: launch. Our dependence on space, given the problems we are facing, requires that we ensure U.S. access to space for commercial and military payloads. The cost of launch continues to be a major driver of our overall space systems. In today's budget environment, we stand to fall into a spiral where we buy fewer and fewer satellites which results in fewer and, therefore, more expensive launches, which results in fewer satellites, which results in fewer launches, which results in fewer satellites, which results in fewer launches, and so on. The last act is, this is the last rocket we have and we didn't have any payloads because we couldn't afford it. We're going to launch that and we've gotten out of the space business. There will not be a future unless we act quickly.

Good news, the DoD now has a plan called the Evolved Expendable Launch Vehicle (EELV). The plan calls for the development and fielding of a family of launch vehicles to handle both medium and heavy payloads using building block concepts to maximize the number of interchangeable parts and, very importantly, reduce the infrastructure overhead. In my opinion, enough studies have been run, enough data collected, all the major players agree we don't have a better option on the table. I'm eager for the plan to move forward from the drawing pad to the launchpad.

We are dealing with fixed budget, so we are essentially in a design-to-cost situation. Our requirements, a mission model, will be provided to industry so it can harvest technology, define a plan and help us to drive to a more long-term cost-effective and reliable launch system. It's anticipated that the stream-lined acquisition process will result in a space launch capability flexible enough to meet both our commercial and our national security needs. If that is not the case, I believe this country will not be able to afford a U.S. launch infrastructure.

So, where are we? Assured access to space, U.S. developed systems which meet our needs, space continues to provide the high ground, a global vantage point, a flexible communications hub. The cyberspace explosion is providing us with new capabilities, a whole new generation of young technogeeks to help us and a whole new way to accomplish our mission more effectively. It is no longer acceptable to provide airmen, sailors and soldiers less than the full advantages of our space capabilities to assist them in their tasks. It is clear to both commanders and troops that significant force enhancement and multiplication can occur if we integrate effectively space capabilities into our military operations. Forces that have adequately trained in exercise with these important capabilities.

The ideas that come forth from conferences such as these will be the very things we talk about as history in space conferences 30 years from now. The only difference between plans and reality is time, and time never stops. We have many of the pieces to meet the challenges ahead. We have a tremendous integration challenge. The integration challenge can be sped along with proper organization. The vision of the future is truly exciting. I encourage everyone not to just plan for the future, but to act on it quickly. Thank you.

It is clear to both commanders and troops that significant force enhancement and multiplication can occur if we integrate effectively space capabilities into our military operations.

GENERAL ASHY: Thank you, Mr. Harris. That's a great start and a great keynote. We appreciate it. Now ladies and gentlemen, I'd like to recognize Mr. Gil Klinger.

MR. KLINGER: What I propose to do is run through three areas, broadly put: where we've been, where we are now, where we think we have to go. I have the benefit of being one of the least knowledgeable people about the technical aspects of space in the Department of Defense and certainly in this room, which is good news for me and bad news for everybody else, because I just soak up what people like Jeff Harris are saying and feel good when I sort of independently have been working on something that seems to resonate with what I've just heard. I think you'll see a lot of things here echo some of the things that Jeff has said.

I guess in opening, let me give you two or three thoughts to think about with regard to National Security space activities in the Department of Defense. They are somewhat related to the things you'll see

here, more related to things we can talk about a bit later.

The first is the FY94 House Appropriations Committee Conference Report, which included language in it that said, amongst other things, "If the management of National Security space activities in the Department of Defense is not broken, it is indeed in need of serious repair," which is a fairly blunt but fairly typical Bob Davis characterization of what the Hill thinks about how we were managing space. It is substantially in response to criticisms that some of the changes that Jeff alluded to that we'll discuss here have been getting made—the bad news.

The good news: Iraqi prisoners of war reporting that when our forces and those of the other coalition members showed up behind them, having executed the left hook, they were thoroughly stunned and equally unprepared. They had simply assumed that since they couldn't navigate through that barren wasteland that they owned in western Iraq, no one else could; therefore, they didn't have to worry about it.

The next piece of news is both a good news and a bad news story. We have gone through three or four different programs for the follow-on early warning system, spent in excess of $2.5 billion, for which we have produced a large amount of technology that we're going to execute right now in the SBIR program that Jeff alluded to. But at the moment, what we have to show for it (to be somewhat flip) is a long set of viewgraphs. And one of the commitments you have on the part of folks like Jeff Harris and General Ashy, the other people up here at the dais, and people in this room is to change that for all the reasons that Jeff articulated and one even more pressing—that we are flatly out of money.

In the wake of Desert Storm and even before it, the good news is everybody saw how effectively we used space. The interesting and somewhat bad news is that now everybody wants part of the action.

So, without all this backdrop, let's go to the first slide *(Fig. NS-1)*. Basically, where'd we come from? Jim Woolsey put it—his characterization was quite accurate—that we have come from a world which is dominated by one large menacing dragon and we have defeated that dragon. The bad news is that dragon has been replaced by a garden filled with a bewildering variety of poisonous snakes and boy, is that the truth. Historically, our space forces were appropriately and very effectively geared toward that single threat, and you can see that described here. You can also see toward the bottom of the viewgraph the change that has occurred, most obviously represented by our recent experiences in Desert Shield and Desert Storm and the other military operations in which U.S. forces are engaged.

Figure NS-1

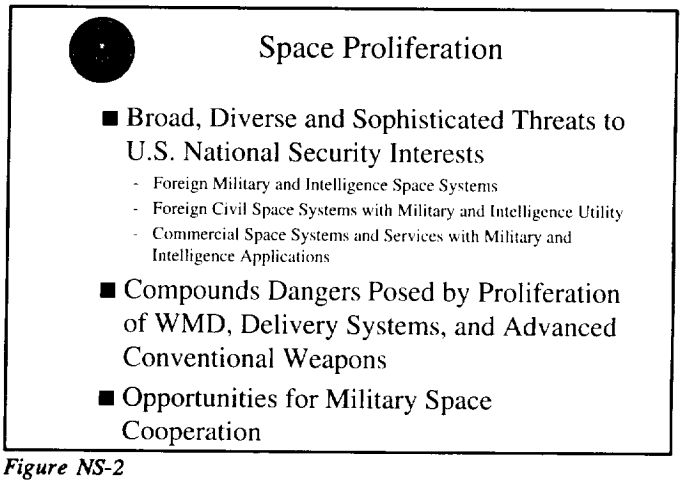

Figure NS-2

In the wake of Desert Storm and even before it, the good news is everybody saw how effectively we used space *(Fig. NS-2)*. The interesting and somewhat bad news is that now everybody wants part of the action. There is a massive explosion and proliferation of other countries, corporations, consortia, multi-national, subnational entities who either have access to space products, goods, services and/or indigenous systems. The problem is that not all of those people have our best interests in mind. You'll certainly remember all those IBM commercials that depict different vignettes of people in Paris or the nuns walking down the street saying, "I'm dying to surf the net." All that's true. The problem is that somewhere in the Libyan desert or in the Bekka Valley, chances are somebody else is also surfing the net. And they are gleaning an awful lot of information increasingly relevant and potentially threatening in its application. We need to account for that.

Imagine, for instance, the military utility that is potentially available from the amount of increasingly high resolution commercial imagery on which will be

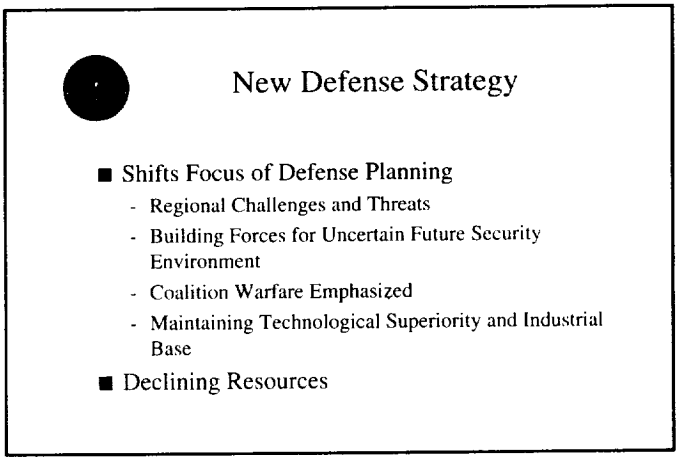

Figure NS-3

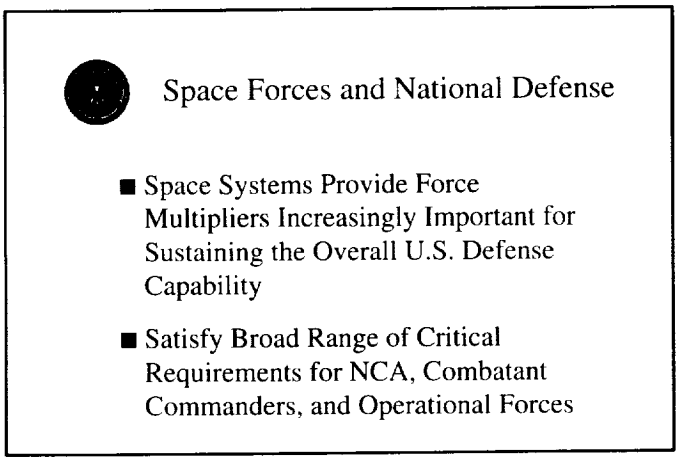

Figure NS-4

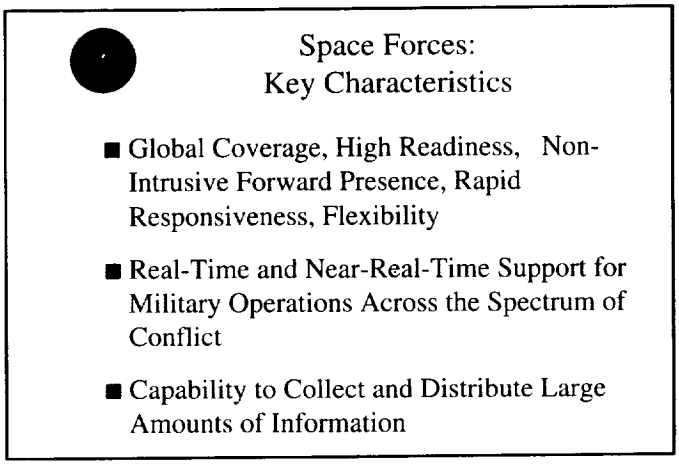

Figure NS-5

overlaid a georeference provided by the Wide Area Augmentation Service of GPS that is going to be implemented in the near future by the Department of Transportation. It is certainly enough to give anyone pause in light of the kinds of installations that are of value to us—civil, commercial or military. We need to figure out what to do about that, even as we unleash the massive capabilities in space provided by some of our industrial partners that are represented in this room. At the same time there's the good news piece to it. There are large numbers of potential areas where we can cooperate with foreign countries and provide some leverage to ourselves and to our allies in an era of ever-declining budgets.

What's happening inside the Pentagon? Pretty much you can see the major themes here *(Fig. NS-3)*. We don't fight alone when we fight and uncertainty is the watchword. If one doubts that, and I doubt myself that anyone would, imagine for a moment that if in April of 1989 I would have handed any of you a sheet of paper and on it was listed any of the things that have happened in the past six years starting with the fall of the Berlin Wall and the breakup of the Soviet Union. I suspect that the first thing that would have happened is I would have gotten a phone call to get drug tested. There might have been more immediate and summary action to lift my security clearances. It is a way of saying, and again, Jeff alluded to this, that if anything is certain in this world, it is change. Rest assured that whatever we thought was likely to happen is probably going to be replaced or added to by something that we never did expect, either good or bad.

The punch line for the Department of Defense is we get to do all of this adjustment, shift this massive infrastructure that Jeff and the others will make reference to in both our classified and unclassified space systems. We are doing not a 180, but a major change in azimuth, from focusing on the former Soviet Union to focusing on the whole world, and it's all happening while the defense budget is declining at an unprecedented rate. One of the things that we have told the Congress, while admitting rightfully that we do have some problems of the type that they have characterized, is, in fact, what I do most of the time or General Ashy is confronted with doing or what Jeff is, General Garner, Admiral Davis, is the single hardest thing for any big organization to do. That's to bring about cultural change. It's hard in the private sector and you're all doing it. Rest assured, it's as hard or harder in the government.

What does space provide to all this from a national security perspective? None of this should be news to you. You can see the kind of leverage you can provide. Even as we draw back our forward-based infrastructures, space provides a nonintrusive capability to do all sorts of things, all of the activities that you heard earlier this morning *(Fig. NS-4)*.

These are all motherhood statements, but they are no less true and no less important, and I can only echo what Jeff said, that we are, in fact, in the age of information *(Fig. NS-5)*. It's a funny thing. Warfare since the time of Sun Tszu has probably really been at its heart about the control of information as a prerequisite to victory, namely, having uninterrupted access to what you needed and denying the bad guys whatever they needed. It's been recognized, however, in recent

times as an important thing to do in its own right. And since the world has gotten much smaller and there's been at the same time an explosion of sources of information that has highlighted the importance of space as a keystone, if you will, of providing the capabilities to collect and transmit and control the flow of information.

We used space during the Cold War to monitor our arms control agreements; we use it now for the same reason *(Fig. NS-6)*. We use it in peacekeeping operations. But the bad guys are disadvantaged in knowing that we are capable of monitoring what they're doing, to paraphrase Shakespeare, through methods that they know not of.

Let's look somewhat at some of the mission areas that Jeff alluded to *(Fig. NS-7)*. In terms of launch, I can only echo what he said. It's impossible to overstate the importance of our providing an uninterrupted, affordable access to space, and the way we are geared toward making that happen is through the EELV program. Jeff made appropriate reference to the vertical stove piping and lack of integration in a lot of things that we have done historically in space. FITAS is the Future Integrated Telemetry Tracking and Control System. It is an on-going attempt being shepherded most obviously by the Unified Command by General Ashy's people to find a way to take the existing command and control systems (the Air Force Satellite Control Network, the Navy equivalent of that) and find some way where we can integrate those systems, break down the software and hardware barriers to having an integrated way of doing business, and, in fact, expand that out so that civil space users such as NASA can also make use of it. It holds the promise for major economies in all sorts of different ways.

Again, you're all familiar with this slide *(Fig. NS-8)*. We take it for granted, but we certainly should not in terms of the massive leverage it provides to our troops and airmen and sailors. I make the point that the Department also recognizes that a lot of these capabilities we make use of on a daily basis have parallel utility for our commercial customers and in the civil sphere, not just in space but in all sorts of terrestrial activities. GPS is perhaps the best example, where we are in a situation in which there is probably a fairly small set of military purposes which are very critical to us, but the Department recognizes the fact that, in stark contrast to that small set, there is a growing set of civil and commercial applications for which we need to provide uninterrupted GPS service.

But the sticking point, obviously, and something we have to work through, is those bad people out in the world that would make use—now and in the future—of those same capabilities for purposes that would do harm to ourselves, our military forces, our national economic security or that of our allies. And those are the shoals through which we have to negotiate management of an issue such as GPS proliferation.

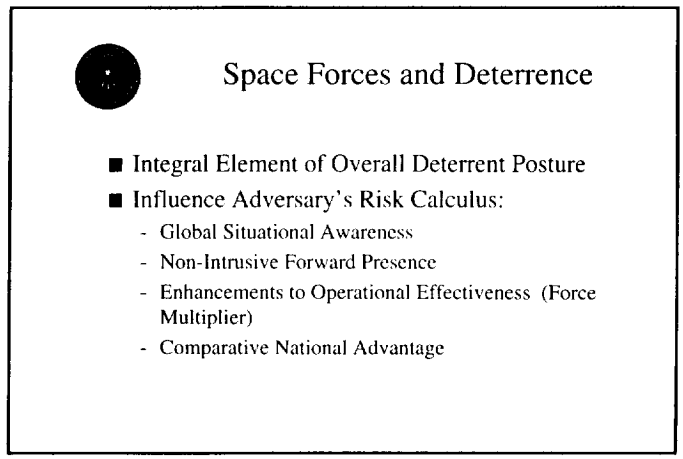

Figure NS-6

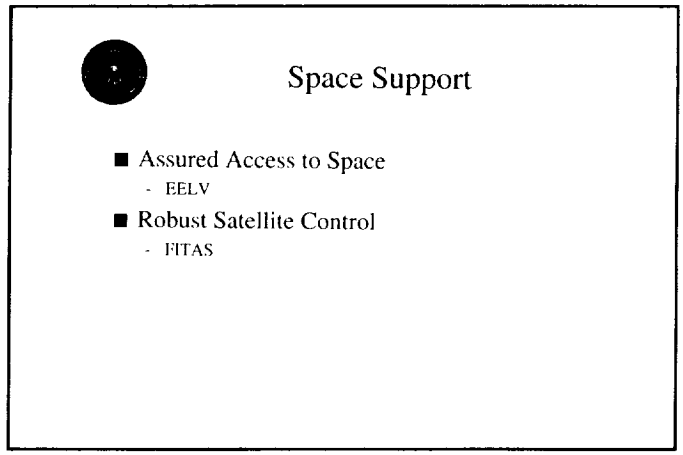

Figure NS-7

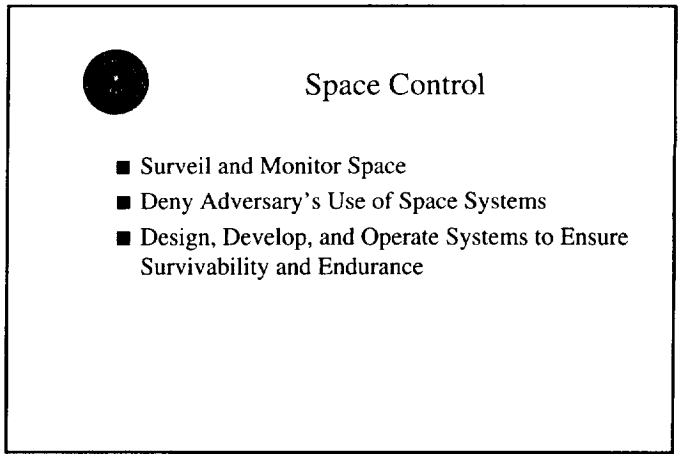

Figure NS-8

Again, to the extent that information control is the key to the future success of our military operations in space and one of the keystones above maintaining that so-called information dominance, we have to be able to have a good handle on what's going on in space *(Fig. NS-9)*.

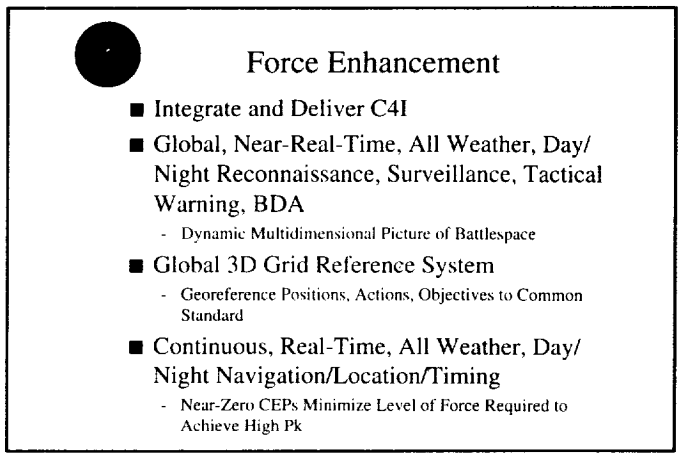

Figure NS-9

Figure NS-10

So what's happening in terms of a policy perspective? You'll see here *(Fig. NS-10)*, I'm going to leave aside any discussion about organizational changes, and I'll be happy to try and address that during questions and answers. Strictly from a policy standpoint, I want to give you a sense of what kind of things we're looking to overhaul the existing Department of Defense Space Policy. You can see those listed here. Again, we have done an exemplary job of moving and changing on the fly. Both the NRO and our other classified space activities and all of our unclassified space activities have done an astounding job of changing direction in response to real time changes in the world. As good as we've gotten, we continue to emphasize the need to do better. The problem, put bluntly, is, in my personal estimation, that the next time we have a Desert Shield and a Desert Storm (My personal opinion is it is simply a matter of time before someone miscalculates American resolve and that of our allies and tries something like it.), the next time we will not have somebody as dumb as Saddam Hussein was to sit there for six months and let us go to spring training, to bring in forces and to fix the problems that we discover in a benign environment. We will have to fight our way in in a fairly hostile environment. That is not the time to find out whatever the warfare area involved, that we should have fixed our problems. It places heavy emphasis on the need for us to arrest those difficulties right now.

This last slide is perhaps the perfect lead-in to a theme that Jeff alluded to—we've got to break down the wall *(Fig. NS-11)*. We spend way too much time in the Department of Defense arguing over who ought to be doing things in space instead of deciding what we should do and how we should do it. Let me assert my personal opinion that if you answered the last two questions, the answer to the first would become self-evident. We need to do a better job of that and are working hard to do it. I think you'll hear some of that today.

That's pretty much all we have to say. I look forward to trying to answer your questions. Thanks.

GENERAL ASHY: Thank you, Mr. Klinger. Our next panelist will be Walt Davis.

ADMIRAL DAVIS: As you might imagine, I'm delighted to be here in Colorado Springs from Washington. I will give you the Navy's perspective on space support as it relates to the maritime warfighter. I will also talk a little bit about where we are, how we are today, and where we're headed tomorrow.

I've got three things I'd like to do here. First, I want to let you see how we see ourselves and our goals. Second, review three or four examples of capabilities developed and innovation in those developments. And then I'll solicit your ideas for future innovations.

For over 200 years, Navy and Marine Corps have provided forces to influence events overseas. National security and national strategies for a Navy that is positioned to deter crisis, respond to crisis when deterrence fails and transition to war as required. Forward presence is the essence of our business. For the Navy and the Marine Corps team to execute its national mission, we must be on the scene with the ability to sustain our actions for as long as should be necessary. We must be forward, now and in the future. A maritime force that is globally deployed and broadly dispersed relies heavily on communications. We have leveraged communications throughout our history, from flag signals to radio waves to radar satellites. The Navy has stood, by necessity, at the forefront of every evolutionary development in telecommunications.

Today we look to space systems for a wide range of force enhancement functions. We see space as a medium for space exploitation by the warfighter, not as some fourth dimension of the battlefield or as a mission in and of itself. It is a medium of connectivity. So we have integrated space into every facet of our maritime operations. To measure weather conditions, to navigate the oceans, to conduct surveillance

and obtain intelligence worldwide, and to communicate both openly and securely to exploit real and potential threats.

The end of the Cold War, however, has fundamentally altered the focus of National Security Space activities. Systems designed in response to the threat posed in the past by the Soviet Union are now providing data points for decisions in Bosnia, Somalia, Haiti and a host of other areas. The top of the national space establishment has become supportive of military operations, as you heard earlier this morning. Operations heavily relied on forward deployed global naval forces as demonstrated so convincingly in the Gulf War. Space support to tactical operations is now an essential element of our ability to wage war.

Defense spending is down across the board, over 40 percent overall and 60 percent in procurement accounts alone. The magnitude of these changes presents us with a clear mandate to streamline processes for maximum efficiency as we prepare to bring the next generation of space system for warfighting support on line. This mandate is entirely in keeping with both the Reinventing Government Initiative and the Federal Acquisition Streamlining Act of 1994.

The Navy has stood, by necessity, at the forefront of every evolutionary development in telecommunications.

It is most recently reflected in the decision of the deputy undersecretary of defense to stand up a deputy undersecretary of space within the Office of the Undersecretary of Space for Acquisition and Technology. Today all of the services are working with this new deputy undersecretary of defense for space to mark a path towards the goal that Congress has placed before us—the unified management of defense and national intelligence space activities.

The Navy believes in doing things faster, cheaper, and better through a lean infrastructure which makes full use of the commercial sector. Tomorrow's space management will require a joint and integrated forum where all the national security space partners not only voice their requirements but also play an active and meaningful role in the satisfaction of those requirements. In this way, we will avoid a process where, as Mrs. Slatkin says, "Decisions are measured with a micrometer, marked with chalk and then cut with an ax."

Done properly, we will find ourselves with a lean organization, streamlined acquisition processes delivering affordable space systems quickly and efficiently, making full use of technology injection, innovation, and the best of the commercial world. The Navy has already started down that path.

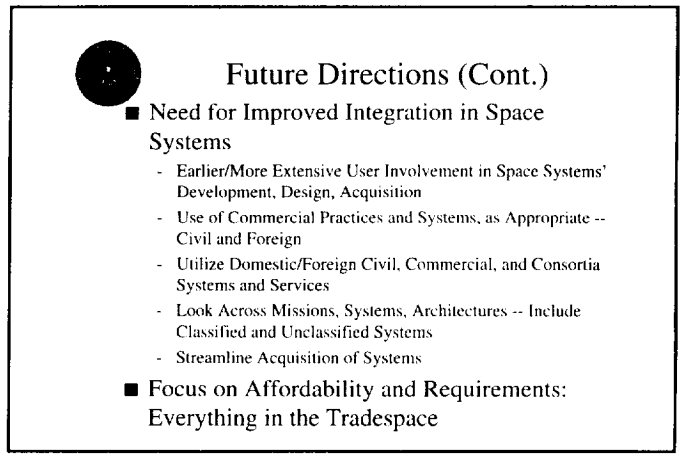

Figure NS-11

UHF follow-on is a particularly good example. It embodies straight-forward functional specifications based on existing commercial technologies eliminating the cost of R&D and UFO's firm fixed price bill and the watch contract calls for delivery of that capability on orbit. We've done that for less than $200 million per satellite. Our nation receives these operational satellites while the contractor who has built them provides a commercial bus that promises to set a new world standard for communication satellites. This program is executed from the program office of only 16 people, yet enough flexibility by the way, and I think that's important, to add EHF capability to the last seven satellites without a missed step. We're now considering the addition of direct broadcast capability to the last UFO satellite. As you know direct broadcast, this technology will reduce to the man on existing two-way interoperable communications by providing multichannel, one-way, high-speed transmission of large data updates as well as high-quality imagery from ashore-to-afloat forces.

Our environment satellite is much the same. The GEOSAT follow-on satellite program has this same model. A four-man program office contracting for a small satellite on orbit capability under a functional specification using commercial standards and practices. It's now scheduled for a 1996 launch, and it's on schedule and on budget.

Challenge Athena. Throughout last Fall's six-month deployment of the USS GEORGE WASHINGTON Battle Group, Navy's project Challenge Athena proved the feasibility of timely delivery of primary imagery to the afloat tactical warfighter. In the words of the Battle Group Commander, this link changed the very complexion of Battle Group operations.

What does it do? Challenge Athena allows us to deliver over 6,500 national images to the warfighter. By the way, in time frames as low as seven minutes the picture's taken out to the warfighter aboard ship—full access to the national intelligence data bases—use of 32 phone lines terminating in CONUS (Continental United States). Telemedicine, which

assisted during that deployment in 105 consultations, eliminated the need for 31 medical evacuations and assisted in the diagnosis of five suspected cancer cases.

Now we're looking at Challenge Athena which will deploy with the Carl Vinson Battle Group next year, providing high-volume data to three joint task force groups at 12 times the data rate currently available in our forces today. And it will demonstrate initiatives for inter and intra Battle Group networking, assistance to shooter links and video teleconferencing, and JDISS connectivity.

I've got several other examples that I could talk about, but I'm going to skip some of those and go to one other technology I think is going to be very important to us, and that is this simulation-based design. Recent ship's design work by ARPA, the commercially produced 777, and other projects attest to the potential value of this new technology. Modeling & Simulation will let us build new, complex platforms and systems faster, better, and more error-free, as we do all the preliminary design and tests work in a computer environment and help us get the real thing out to the warfighter at a lower cost.

As we move towards integrated management for National Security Space systems, we must ensure that the field remains wide open, in our opinion, to give incentive for competitive innovation. Each service and each agency has something to bring to the table. Navy expects to lead and not just play where our primary interest lie. We have long recognized the value of space to the afloat warfighter. After all, it was for this purpose that we established the Naval Observatory in 1844.

We are in the midst of a time of significant change that is no less revolutionary than the advent of steam propulsion, carrier aviation or nuclear submarines. The so-called revolution in military affairs has moved information and the requirement for information dominance to center stage in our thinking about modern warfare. Successful implementation of these innovations requires that they be integrated into our doctrine, our strategy, and our systems. We must cross that threshold now.

We like your theme because we do truly believe that tomorrow's reality can be brighter than today's vision. In fact, if we look at today's reality of yesterday's vision, we've found that we, in fact, have already been able to do that. So for a swift ship and a trim crew, we'll have the tools that they need to maneuver any challenge that may await. This is what we call the way ahead.

Thank you very much.

GENERAL ASHY: Thanks Walt. This guy's Jay Garner.

GENERAL GARNER: Thank you, Sir. I've got a dozen slides and I'm going to cover them in about that many minutes (slides not available). What I want to do is sort of focus on what a small Army does in the 21st century that's CONUS-based and how it goes out and fights and what poles it needs from space to do this. Put the first slide on.

I think General Rosenberg had it right. What that slide says highlights a statement Gil Klinger made when he said, "Hey, what we need to do is quit worrying about who does what and figure out how we're going to fight in the future, what we need from space, and all the rest of that stuff will fall in place." That's what I want to talk to you, and how the Army's going to have to fight in the future. Put the next one on please.

The military strategy says O.K., you've got to go out and win decisively. You have to do that because that's what we want to do, plus as you noticed on the slide before, talked about coalition warfare. Coalitions don't hang together very long, so you need to get in there and do your business and get out. We have to do it with minimum casualties because we don't like to take casualties, No. 1 and No. 2, because of the political pressures it brings upon us. So the Army of the future is going to be required to project its force. Once you've projected it, you've got to protect it. Once you have it in place, you have to be able to control it. And for the land warfare guys, you've got to maneuver and be able to kill the enemy. Put the next one on, please.

So what do you need from space to do that? Look at the environment over there. Deployments are going to be forward based. That means we've got a small army. We've got to get it there and in order to project it we've got to do split-base operations. We've got to do absolute Intelligent Preparation of the Battlefield (IPB) before it starts and en route. Smaller forces are going to require that we absolutely have leak-proof defenses. We've got to be able to challenge enemy missiles throughout their life cycle. From building them in the factory, throughout the infrastructure, all the way to finding when they're placed on the ground to killing them in every phase of their launch once the trigger's pulled—boost, ascent, and terminal. And it has to be leak-proof.

Information-based warfare, Jeff talked about that a lot. We've got to control the force. We've got to have absolute situation awareness across the boards, across all services, and where that really gets difficult is when you're dealing with coalitions. Hell, we can't even do it among ourselves right now. We've got to have real-time intelligence, and for the Army and the Marine Corps, we're now engaged in digitizing our battlefield. And that also brings big problems when you deal with coalitions. And then we have to have increased operational tempo. The way we win is doing things inside the other guy's decision cycle. Having an

operational tempo that's so overwhelming that he can't respond to it. In order to do that you've got to know your environment. Blue force tracking; you've got to know the enemy. Red force tracking; you've got to have common situation awareness across the joint force. Next slide, please.

So what do you get out of space? We've got split-based operations. You've got to always have Intelligence Preparation of the Battlefield even on the move. You've got to have global communications to look on the righthand side of that. You've got to have long-haul comms. You really have to be able to do mission rehearsals, virtual rehearsals, before you get there. No soldier, sailor, marine, or airman ought to get in theater in the future with a blank sheet of paper. He'll have already been rehearsed through it at home station against the weapons he's going to face. Long-haul satellite comms, absolute mapping. Next slide, please.

As we project that force, over on the left that's kind of the stuff we do right now. We do a fair job of mission planning and rehearsal systems, a fair job of multi-spectral imaging. We dig up pretty good TENCAP systems. But we need to go in the future with better jobs on weather, man portable UHF, enhanced GPS, down to about one meter resolution, and then all the way to where we have GPS follow-ons, SatCom paging, laser tracking. That's how we'll do it in the future. Next slide, please.

How do you protect that force? We've got to have absolute threat warning. We've got to know exactly when launch occurs, where it occurred from, and where it's going to impact so we can whittle that down to the unit that's going to be impacted. And we need precise targeting where the launcher was when it fired so we can kill that launcher where he can never fire again. Flawless missile defense that is leak proof, common situation awareness, and minimum casualties.

I'll hitchhike on what Walt said on telemedicine. In the future, we have to be able to have our medics in the battlefield hook up the wounded soldier or the marine; have that piped back to the experts, maybe at Walter Reed; and have that subject matter expert save that soldier or marine's life. And we'll be able to do that in the 21st century, but it's going to take space to do that. Next slide, please.

Today we do a pretty good job of warning, but we have to do a lot better. We're beginning to get into telemedicine. We're getting into battle management where we fuse together all phases of the theater missile defense battle, the attack operations, the air defense piece, passive operations to deal with bio-chem, nuclear, and then have the battle management system tie all that together in a synergistic effect. Take all the great TENCAP products we have on all these huge trailers, trucks and everything; shrink it down to about six humvees, where we have better capability, much smaller force able to project it; and then go into these things in the future. Especially in chem and bio detection on the battlefield. Next slide, please.

Now how do we control the force when we get it there? Again, we have to have a common situation awareness, and that's across the force. I'm not talking about CINC to CINC. I'm talking about soldier to soldier, tank to tank, Bradley to Bradley, aircraft to aircraft. Absolute navigation on every one of our platforms. GPS on every platform, to every soldier, every truck driver, everybody ought to know where he is, where he's going, where he's got to be. He ought to have common situation awareness with the force, and we do that with real-time intelligence. And on the right, you see how we get that from space.

We're getting into battle management where we fuse together all phases of the theater missile defense battle, the attack operations, the air defense piece, passive operations to deal with bio-chem, nuclear, and then have the battle management system tie all that together in a synergistic effect.

Big one there is broadcast intelligence. What we need to do with broadcast intelligence is have it in such a manner where it is winnowed right down to the user. You don't overpower the guy with too much, but what he needs to know is winnowed right down to the guy that needs it. Put the next one on, please.

So to control the force the way we do it today, of course, our backbone is DSCS. In the future we need to be able to do DSCS smaller and do it on the move. We need to get into the man portable SatCom business, and we need to get into Tri-band and Star-T. And then you look over on the right here, again it's SatCom paging, SatCom on the move, global broadcast systems, and we really need to start getting into laser comms. Put the next one on, please.

Now, what's it do for maneuver? What we want to do is really shrink down the decision cycle on the other guy. Operate at such a high operational tempo that he can't respond to what we're doing. He can't react to what we're doing. In order to do that, you absolutely have to know the environment—everything about your environment, the Blue environment, and everything that we know from all means about the Red environment. To do that, we're big on breakdown link, continuous comms (especially comms on the move), real-time weather, absolute terrain analysis, real-time targeting and a deep-strike capability where we can shape the battlefield that we're going to maneuver on in just a matter of minutes or hours. Next slide, please.

So how do we get there from here? We're doing fair right now, but what we're really going to do is digitize the battlefield, but we can't digitize the battle-

field without big pipes and a lot of poles from space. SatCom on the move, multiple sensor platforms (put a lot of stuff on one platform) and automatic target recognition, where you see it you know exactly what it is and you can target it and hit it. Put the next slide on, please.

So here's what we need from the Army standpoint. We need to improve our sensors, processors, communications capabilities and have space control; and we do it with those things on the right. Multi-functional rays, a lot of stuff on one platform, on-board processing (get a lot of data to the right guys at Wright Patterson AFB), assured access, whereas when the war starts you're not used to getting it at 6.5 like Schwartzkopf was used to getting it. It all of a sudden went to 1.5 because there are too many users. And in space control, all I'll tell you there is I believe what General Rosenberg says, "The other guy's going to use space too." If we're not going to have the capability to take down the satellite, we sure as hell better have the capability to take away what the satellite is giving him. Put the next one on, please.

In a doctrinal sense, space is recognized as a fourth medium, the other media being air, land and sea.

So that's our vision for space in the Army. It just says in the future, the Army warfighter has got to be able to use space as a sanctuary from which he observes the enemy, he directs his own operations, and he denies that same capability to the enemy. Thank you.

GENERAL ASHY: Thanks, Jay. Roger DeKok now.

GENERAL DEKOK: Thank you, Sir. Speaking of principles of war, I think we just witnessed another demonstration of a principle of war: how effective maneuver is in preventing enemy targeting as I witnessed the photographer try to get General Garner's picture. That was quite impressive.

I'm going to talk for the next 10 minutes or so about a topic that has nothing to do with space systems themselves. I'd like to talk about a topic though that has been the subject of some controversy over the past six to 12 months and that's the topic of organization. But I'd like to draw a clear distinction at this point. I'm here to talk today about the proper organization for operations. There's been a lot of talk, there's been a lot of action, and indeed there's going to be more action inside the beltway on the organization of Space for Acquisition and I suspect there will be questions, as Mr. Klinger suggested, on that. But I'd like to focus now for a few minutes on the proper organization for operations. Next chart, please.

I'd like to offer some considerations for you. Although our doctrine is relatively mature, history suggests to us that the high ground has always been important in warfare and, as I believe all of you recognize, space is the ultimate high ground. The vantage point from which military operations can be observed, controlled, and ultimately conducted. In a doctrinal sense, space is recognized as a fourth medium, the other media being air, land and sea. Interestingly though, Space Command, Unified Space Command, is the only military organization that is actually assigned missions in space. As General Ashy has indicated, we've done a lot of thought about what that means in a doctrine and organizational sense.

If I can have the next chart please, you'll see depicted the current organization of United States Space Command. It has the three service components that are attached to it—Army Space Command, Naval Space Command and Air Force Space Command—and the Air Force Space Command that supports U.S. Space Command is 14th Air Force which is commanded by Major General Bill Jones at Vandenberg Air Force Base. Just as General Horner was the Air Force component commander to General Schwartzkopf in the Desert war, General Jones is the Air Force component commander to U.S. Space Command. The real question that arises in looking at this chart is, is this organization the correct one for space operations?

If I could have the next chart, please. This is perhaps the key chart in my entire presentation. It depicts areas of responsibility, and that, of course, is how the commander-in-chiefs of theater commands are assigned geographic areas of responsibility around the globe. Now notionally depicted on this chart are the land, sea, and air boundaries that are uniquely assigned to an individual commander-in-chief of the theater. The boundaries between land and sea and between land and air obviously are well established. Not so well established, however, is the boundary between air and space. Exactly where do air operations end and where do space operations continue? Of course, we can talk about astrodynamics as opposed to aerodynamics as being one of the dividing lines, but that boundary itself in a doctrinal sense and, indeed, in a policy sense is somewhat indistinct today. However, we do have what we call supported CINCs. In the Gulf War that was General Schwartzkopf as CINC Central Command. He was supported, however, by other CINCs in this process. In the Gulf War, the best example was European Command which provided a great deal of support to CENTCOM, and they were the supporting CINC in that process.

Overarching all of those areas is this medium of space. This is an important doctrinal distinction that I'd like to make. Only U.S. Space Command is assigned operational responsibilities in that medium of space, and that's an important consideration, I think,

as the doctrine for Armed Forces evolves and as it affects space. Next chart please.

And, of course, as an overarching medium, space supports all of our Service components. I think my colleagues have very adequately described the importance of space in supporting land and naval operations. This doctrinal chart raises some interesting questions. Is our current organization for space correct? As you all know, there are commissions like the Commissions on Roles and Missions that are looking at these kinds of issues under a charter from the United States Senate. People have suggested that there may be alternatives to the current way we organize. Some people have suggested that it may require ultimately a fifth military service and some others have suggested that the United States Air Force should be a specified command in charge of space responsibilities.

I'd like to talk about those here for the next minute or so. I think the notion of a fifth military service is quite bankrupt from the start, particularly given the resource implications and the overhead associated with a fifth military service. Clearly, I believe, out of the question today. The other alternative, a specified command, is often prompted by the considerations on the next chart. I think it's undeniable that the Air Force has a preponderance of the resource allocation devoted to space, both whether you measure it in dollars or whether you measure it in people. I would like to suggest to you that that resource allocation that results in the preponderance of the Air Force contribution is in many cases a representation of the fact that the acquisition of space systems, multi-service space systems (I might add) has historically been an Air Force responsibility and it accounts for the majority of the Air Force dollars and people who are currently allocated to space. So if I could have the next chart please, which is my concluding chart.

As we look through this process, we recognize that Goldwater-Nichols assigns to unified commanders the ability to organize their components by either service or functional components, and clearly it's a service organization today in U.S. Space Command. It also assigns to U.S. Space Command the missions of space control, force enhancement, space support and ballistic missile defense, and space operations. And U.S. Space Command, as I've already stated, operates uniquely in the medium of space.

From all of the above, we conclude that the current organization of service component responsibilities is clearly the proper one for space operations, and I'll be glad to take questions on organization during the Q&A. Thank you very much.

Q&A

GENERAL ASHY: This question's for both Mr. Harris and Mr. Klinger. What's your level of confidence that we'll field SBIR in a quality, timely manner?

MR. KLINGER: You know, this is one of those glass is half empty/glass is half full approaches, and I tend to take the glass is half full approach. Fifteen months ago nobody would have bet a dime that we would be where we are, either from an organizational standpoint or with regard to the SBIR program. Quite frankly, it hasn't been a picnic by any stretch of the imagination because of points we were making earlier. It's a cultural change and that's a hard thing to do. And it's habit and it's mode of operation and all of the things that grew up over 35-some odd years of doing business a particular way. But having said that, we're here.

We have validated requirements that everyone has signed up to. There is consensus above the level of the lowest common denominator. And it's not just consensus that matters, because we frequently get consensus in the Department of Defense; we just get it at the minimum everyone can agree upon.

That is not the case with this early warning program. We have an unprecedented situation in which folks in Jeff's organization—and all of the other stake holders in space—all the way from the combatant command user level all the way back to Los Angeles where Space & Missile Command is, out here in Colorado Springs, and inside the beltway all got together and said we need to do business differently. Is this as far as we need to go? No. Is it the best of all possible worlds? I'm not sure I know what the definition of the "best of all possible worlds" is. I do know that what we have are fairly rigorously defined requirements that have been scrubbed and continue to be scrubbed.

We have a high level of cooperation between the working level people up and down Jeff's organization and the Air Force. We have the active participation and cooperation of all the other uniformed military services, their civilian secretariats and the office of the secretary of defense. And quite frankly, we have the firm commitment of the secretary, the deputy secretary and my boss, Paul Kaminski. If for no other reason that nothing focuses the mind like the prospect of a good hanging, we have a full-up commitment to make this work. We are in uncharted territory, both organizationally and in terms of how we do business, which is to say there are going to be some turns down the road that we decide after some number of weeks or months, "Nah, we've got to do something differently." But we have no choice but to execute this program. We have no choice but to change the way we do business in space because there is no question that if we are perceived as having failed to do so, the Congress is going to move in on us and change it for us. And by their own admission, they bring a meat ax and not a scalpel to the job which really requires a scalpel. So I guess I don't view this as a bad news story. This is a resounding good news story to me. I think it's sort of unreasonable to expect us to be able to go from where we were to where we want to get to all in one step, in part because we're not sure of

where we do want to get to, as I said earlier. But I think this is, in fact, a good news story.

GENERAL ASHY: Mr. Harris, would you care to amplify?

MR. HARRIS: To make it easy—Jay Garner said that theater missiles are a threat. We all understand that. We've stopped building DSP which doesn't address that threat. We have the time, we have the money, we have the technology.

GENERAL ASHY: From my perspective, I agree. We have no choice. We have consensus. I think we have the technology and to bring an added perspective or umbrella to this process that Gil and Jeff both spoke of, I think through the JROC process. Having taken the requirements that everyone agreed to last summer to that process, I think we have unanimous agreement and commitment. So, I think the future is bright when you put all those together.

Before Gil leaves, let me fire-hose him a little bit. We're getting a lot of questions here on perspectives on space control. I think Jay covered it very well. Perhaps Gil, you could give us your perspective on space control and protection of our side, and denial of the other side.

MR. HARRIS: I think that as my presentation and the other presentations alluded to, we have always placed a heavy emphasis on knowing what's going on in space. A lot of that emphasis came from our civilian space operations where we had safety of flight considerations and continue to have safety of flight considerations, first for Mercury, Gemini, Apollo and now for shuttle operations and in the future for the space station. None of this is in fact news, that's the first thing I'd say. We have had an emphasis on being situationally aware with regard to space since 1957. What's changed is our ability to fulfill that set of requirements, so that is not new. I think it was Jay who made the point that everyone focuses with regard to space control on what's up there. What's up there is really a delivery truck. It's a collector in some cases and a delivery truck in other cases.

What the Department of Defense needs to do is keep the bad guys from getting the information that they need, wherever it came from and wherever it's being passed. Therefore, if I put a 500-pound bomb through somebody's SPOT down-link in Baghdad, that's space control. There are lots of ways to do this job. They are inextricably woven up with the bigger picture of information control, and in that sense I guess I focus less on space control per se as the relationship between space control and information warfare, if you will, or information control. Making sure we have enough protection for our on orbit communications links and terrestrial infrastructures, a piece of that equation. Obviously it's an area we are focusing on now and will continue to focus on. But I don't want anyone to have the impression that this is a new problem or a new set of issues. What's changed is the emphasis.

GENERAL ASHY: Thank you. Question for Mr. Harris. When will the NRO declassify its organizational chart and release documents?

MR. HARRIS: In the Fall of 1992 Secretary Cheney declassified the NRO and our seven employees. We are quite proud of what we do with those seven employees. This year we will complete the declassification of the overall organization and the folks who have led to our successes over the years in the acquisition of space systems. I suspect we'll have that all done in the next month or so.

GENERAL ASHY: From my perspective, the NRO and Mr. Harris are trying very hard to work with us because I think it's key to supporting the warfighter, although most areas will not become unclassified. We appreciate his efforts.

Before Mr. Klinger leaves, we have a couple questions here on the organizational business as you referred to it. Could you expand on that please?

MR. KLINGER: I just want to go back to a point about Jeff's organization. Given its mission, the NRO is the most agile, the most innovative organization we have in the acquisition phases and operations in the Department of Defense. Its accomplishments are nothing short of awesome. It is a convenient stalking horse for the people who point to the problems that we have in space, just as the United States Air Force is a convenient stalking horse. That's just an unfair characterization.

The Department of Defense corporately has challenges and problems it needs to address with regard to space. Those are not confined to any single organization, party, individual, office, whatever. But I will tell you that the flower of what we do as a country technologically, much of that resides within Jeff's organization. One of the things I often sort of lament is that for national security reasons we were unable to demonstrate that more openly. It would be a source of pride for everyone who is a taxpayer. But this debate gets misplaced and polarized, and it has been and is a source of great frustration to everyone in the office of the Secretary of Defense and, I think, most people in the Department.

We need to do space more like Jeff's operation and not less. And when we do that, we will be a good way down the road toward addressing a lot of the problems you've heard described earlier.

Now, what was the question? I'll expect payment for this later on.

GENERAL ASHY: Space policy and organization—an update.

MR. KLINGER: The Office of the Deputy Undersecretary of Space has been established. We are in the midst of identifying floor space, computers, and all of that good stuff while still attempting to execute the mission of the organization.

The mission of the organization is to provide an OSD focal point for the universe of space-related activities, no pun intended. Previously, those functions are split over the Policy organization where I was, the Acquisition and Technology organization, and within Emmit Page's Command, Control and Communications and Communications organization.

What we are trying to provide, amongst other things, is a one-stop shopping location for space issues which would relieve the burden that all of the services and defense agencies now face of having to run all over the place inside OSD. When they ran all over the place they really didn't get good answers to a lot of their questions. We had a fragmented approach to dealing with space, so that's one piece of the mission and we're on our way to doing that.

The organization will be populated heavily by folks from all of the services as well as the NRO and the other defense agencies. It is not the mission of the Office of the Secretary of Defense to replicate the existing capabilities resident in Jeff's organization, in the Air Force, in the Army, in the Navy, and at DISA. Rather it is the mission of the organization to provide a nucleus of people who do have a capability to survey what is going on in all those organizations and, more to the point, tap into those resources and work with them.

Paul Kaminski differentiates between what he calls "doing it" functions or execution and "see to it" functions which, for lack of a better term, are oversight functions. There are three basic areas for the OSD organization: one is policy, the second is architectures, the third is programmatic. It is in the policy organization that you will find the lion's share of the execution functions within the new OSD space organization. That organization is responsible in working with the Joint Staff, the Unified Command, the NRO and the services for formulating DoD space policy and seeing to its execution and implementation in whatever form that occurs.

With regard to the architectural office, the principal responsibility for that office will be to work with the as-yet to be developed or under-development DoD space architect to break down some of the barriers you heard Jeff and others describe this morning. Bust down the vertical stovepipes and create a much more horizontally integrated approach to doing things. I'll give you an example. If we'd had that organization set up 15 months ago, the DoD Space Architect would have run the SBIR summer study. If it was set up now, it would be running the MilSatCom architecture study. All of those cross-cutting issues and looking both within missions, whether it's MilSatCom or launch, the execution for that will be in the DoD Space Architect; the OSD component mainly charged with working with the DoD Space Architect. The Programs Office within OSD, as the name indicates, to make sure we've got the funding streams right and we have technical issues to work out supporting the acquisition process, but doing so in a much more streamlined manner.

One of the things that Paul Kaminski, John Deutch and Bill Perry are committed to is shrinking the time scale by which we do acquisition-related process with regard to everything in the Pentagon, but particularly with regard to space. Those of you involved in the SBIR activity hopefully have seen that manifest already. You'll see more of it in the future. Heavy emphasis also is placed on involving the operators—General Ashy's organization and the other CINCs—very early in the process. (I think Jay alluded to the fact that you have to get the other CINCs involved, the warfighters involved, early on to identify the requirements and articulate whether those are real.) Those are some of the things that we will be doing. The process is occurring today back in Washington. We are working with the Air Force, which asked to come back to the Secretary of Defense with recommendations about the DoD Space Architect and that is occurring in real time.

GENERAL ASHY: Any other additions to that from the panel members? General Garner mentioned integration and the challenge of that. I'd like to ask the service members on the panel to comment on how you see the future. I think Jay mentioned it and its importance. Let me start off with Walt. I think you mentioned it in your remarks. I think it's important, so could you give us a little bit more detail on your perspectives?

ADMIRAL DAVIS: It's essential to us. I think I did mention it in ours. The focus is to win. We said at the beginning of this that we're going to win jointly, and if we're going to win jointly, then we must be in agreement. I don't think that that has been a challenge, it's not been an obstacle at all. The cooperation among the services today to do that, in my opinion, is great. We realize that.

GENERAL ASHY: Jay, you said something about that already. I think certainly I received your point on its importance.

GENERAL GARNER: I think we're on the road to common integration among the services. Right now, from my experience, we make it work, but it's awful hard to make it work. As we go down this road, I think we're getting closer and closer together. Where we're going to have a problem in the future is with coalitions, and I think I said that a couple times. And I

don't know how you solve that problem. Eventually I think you'll see all the services coalesce and we'll probably be pretty well integrated, but I don't know how we solve the coalition problem.

GENERAL ASHY: Roger? Anything to add?

GENERAL DEKOK: Sir, I'd just like to add one additional perspective. I think the highest leverage opportunity is to get the services together early on in the requirements process and to have them participate in the trade that Mr. Klinger talked about in terms of affordability vs. capability. And I think if we could do that early in the process and get the requirements established and understand how far down we are in the requirements cost capability trade space. That would be the best thing that we could do.

GENERAL ASHY: O.K., thank you. We've just received several questions which I think were prompted by Gil's remarks on the organization and the architect and so forth, and it has to do with the perception of Air Force control. I hope Roger dispelled that; from my perspective it has been dispelled. Let me just ask Walt and Jay to comment. I think we've got that sorted out, but let's ask representatives of the other two services. I'm purple-suited, so I'm not in this argument. Jay, let me start with you. I know that as a component commander we've addressed that in the joint way, I think we've got it sorted out. I'm not so sure that there's an issue with it, but maybe there's a remaining perception. Your thoughts, please.

GENERAL GARNER: About two months ago I guess, the vices all met with Paul Kaminski, Gil, Jeff, and a few of the rest of us. We all agreed to what's happening right now. I don't remember there being an awful lot of arguments with that. We all agreed to the way things are being laid out now. From the Army perspective, what we've asked for and have received is we said we want a place at the table to delineate our requirements for space. And we're receiving that. We want to maintain control of the ground terminals, we're doing that. And we want to keep our own unique TENCAP business but certainly there can be some oversight there to make sure all the TENCAPs aren't doing the same thing. And that's happening. So as I see it, things are progressing pretty good. I'm really not upset with the way things work.

ADMIRAL DAVIS: Gil hit it on the head when he was talking about the architect. That's certainly recognized by the leadership that that architect's office must be made up of everyone. That's the only way we'll be able to do this. So as long as we keep that perspective there'll be, I'm sure like all organizations down in the bowels there, folks that feel differently about this and will be fighting for what they think is control. But I think that since we have leadership that understands this, this will be resolved in the right way.

Jay hit it on the head. If we go back and focus on the right thing, most of those things will settle out. So if we focus on what we're trying to do, that'll settle out. We've got a good example of that, by the way, where there's not controversy. That's in the development of the Global Command and Control System. There we're all on focus, there's no argument, everybody is focused in there and that's evolving in the best way. Perhaps we can follow that example.

GENERAL GARNER: I think we're all kind of in agreement. All I'm waiting on is to find out how many Army guys I can stick into this organization so I know what they're doing.

GENERAL ASHY: From my perspective, this is a very important issue that is certainly lesser of an issue. We're all in agreement, we're on record in that regard, we've answered questions and made recommendations to the Roles and Missions Commission from the Unified Headquarters. As all of the panel members have pointed out, we're not going to improve and fulfill our visions unless we cooperate. From the Unified perspective, we are organized properly with service components. Every service contributes to the fight; therefore, they must have the right and have the obligation to participate in the process that leads to some of these capabilities that all of the panel members have talked about.

What Mr. Klinger talked about is primarily how we're going to fuse that at the top in terms of policy and acquire the systems once we decide on what we need. I think that's fair to say; is it not true, Gil?

MR. KLINGER: The only thing I'd add from an OSD perspective as a civilian—with 30,000 people in the Pentagon—especially as a civilian, it is very difficult to stay in touch with what the mission is. I've been fortunate because I work with people and work with civilians who are aware of this. My mission is to support the warfighter; not much else makes any difference. Change in our business frequently starts at the top and what you're hearing is a good news story in that that change is occurring from the top down. All of you know that lower down in individual program offices where, at any given moment, people are fighting or haggling over this/that/the other thing, that cultural change hasn't pervaded as far as we'd want it to. That's going to take time. That's the nature of the business. But the message that we are sending, I personally believe, is that if we do not have an operational focus that's principally geared toward supporting the warfighter, the only good news is—and it's because it's the lesser of two evils—is that we're going to fail organizationally and the next time you have one of these conferences, there'll be somebody else sitting here.

The down side is that people are going to die. If we don't fix what we have to in space, the next time we have to send men and women into combat, some of them will die who will not have had to. If that is not a reason to get our act together, I don't know what is. That imperative drives me every day, drives the people at this table every day because they are obviously much closer to it than I, and certainly drives my management. There is a sense of urgency about what we are doing in space for a whole variety of reasons, but at the bottom line, that is the greatest urgency.

GENERAL ASHY: Thank you gentlemen. Mr. Klinger, could you give us your perspectives on the relationship between the ABM Treaty and the need for National Missile Defense and Theater Missile Defense and where all that issue is. A very easy question.

MR. KLINGER: Sure, sure. To my infinitely great good fortune, I have nothing to do with the arms control business and I never have. I was in the targeting business, which was the other end of this when I was in the strategic business. I would ask all the arms control people to leave the room so I could get done what I needed to at that point. So I'm no expert on this issue.

I think obviously if you read the papers and you hear, those of you who are inside the beltway hear the various and sundry stories of what's going on. This issue is in play. All I can give you is the following, very personal perspective—and that's exactly what it is.

To the extent that we have a requirement beginning to border on urgent to provide a theater missile defense capability, to the extent that in the future we may decide that that requirement extends over to national missile defense, my personal opinion is that we would have to take a hard look at the existing treaties in place that made an infinite amount of good sense when they were signed and to a large measure make sense now.

If we believe that the threat is of a character that our men and women in uniform and those of our allies are at risk, I believe it would be foolhardy for us to fail to take the actions necessary to protect our capabilities and our people, our most valuable resources, merely on the basis of what I would believe at that point and in those circumstances is adherence to an obsolete piece of paper. The treaty is obviously much more than that. It is valuable, it is in our national security interests, it is in our foreign policy interest. But it is not immutable. Times have changed, and to the extent that those times and the threats and challenges we face, the ones Jeff alluded to, I and my colleagues need to take a very hard to look at what kinds of modifications or changes—and I don't know that there necessarily are any. That's for the lawyers and other people to decide. But the ABM Treaty was a treaty negotiated under a certain set of presumptions and in a certain time period where the world looked to be a certain way. I don't think it makes much sense to simply continue. If, in fact, we decide that many of those conditions have changed, it sort of fails my common sense test to continue to adhere to that document for it's own sake. I also don't subscribe to the notion that the whole house (all the other arms control treaties that we think still make sense, and the remainder of the ABM Treaty), I don't buy the notion that the whole house of cards comes crashing down if, in fact, you begin to make modifications that we and our negotiating partner believe are in our mutual national security interests. I just don't buy that argument.

GENERAL ASHY: As a follow-up to Mr. Klinger's remarks, let me ask Jay and perhaps Walt to give us an update on where you are with testing of core systems, AEGIS and THAAD perhaps. Jay, let me start with you.

GENERAL GARNER: We are just beginning to do THAAD flights. THAAD seems to be going pretty well. It's been pushed to the right a little bit, but most of that was due to a $65 million Congressional cut that we got in '95. It seems to be going pretty good.

We're in dialogue with the Navy on Upper Tier, not necessarily Marinize and THAAD, but on working the leak kill vehicle for the Navy and doing some other work there. We are beginning to increase our capability at Kwajalein to test at multiple ranges for the theater missile defense threat. We're trying to obtain another island to launch from so that we can do some testing between the 400-500 kilometer range. So I think all that's coming along pretty good from an Army perspective.

But I put on sort of my military hat and take off my Army hat. The problem, I think, in theater missile defense is because of the lack of resources. We're playing system vs. system, and that's the wrong way to do it because the theater missile threat is here now. And everybody's proposed a system that brings a lot to the table. And I'm going to tell you, that's the show stopper of the next war. So I think it's wrong, say, to play off Army Upper Tier versus Navy Upper Tier. I think the Navy has to have an Upper Tier because that's the only way your going to get, in certain scenarios, some ascent phase shots, which are really critical. Look at the longer-range missiles being fired out of, say, Libya into Europe to perhaps threaten us with our force projection. We can take our Army Lower Tier and Army Upper Tier and we can protect some places in Europe, but we can't protect everywhere. So we only have a finite number of assets we can protect. But if you had an Upper Tier capability, say a Naval Upper Tier capability, you could come right off shore and get many of those missiles when they're fired in the ascent phase.

So you say, well, maybe you ought to have a Navy Upper Tier and an Army Upper Tier. Well,

there's too many places where the Army operates that's so far inland that the tether is no longer long enough to protect us. You can't trade those two systems off—you've got to have both of them. I just don't think you can get enough people, or enough of the services, in the missile defense business right now because, if I was on the Red team, the first thing I'd try to do is prevent our force projection and the way I'd try to prevent our force projections is with weapons of mass destruction. And the way I'd deliver weapons of mass destruction on you is with theater ballistic missiles and cruise missiles. So I don't think you can have enough people in the business.

ADMIRAL DAVIS: I concur fully with Jay on that one. As he mentioned, that threat is here today. We're having some great success, I believe, with cooperation to try to get some of the things we have to work, corporate engagement capability is one of those. Tests on that are showing great results and that's something we can do with our existing capability and integrating them. There we are back to that integration word again. It's all we're really doing with that and trying to use it in the best way. So I think that's surviving well.

I think this tremendous vision of all the leaders is there for that kind of thing and I think the cooperation among the services is there to make it happen.

GENERAL ASHY: From my perspective, I couldn't agree more; and I think what the two gentlemen said is we need defense in-depth, and a term I've learned from my Army colleagues on the Unified staff: We need to buy battle space. You need to be able to detect before they take off, as Jay said in his talk, but if they do get airborne, you need to shoot them early. And it needs to be a big umbrella and you need to have more than one chance. And I think that's what Jay's saying. Is that basically true?

GENERAL GARNER: I think you need to be able to kill them in every phase of their flight.

GENERAL ASHY: Absolutely.

GENERAL GARNER: I mean, you can't kill them all in the boost phase, you're not going to kill them all in the ascent phase. Some of them are going to get through so you have to have some terminal phase stuff.

GENERAL ASHY: And everyone contributes. I think that's what both gentlemen are saying. So, in that regard, we've got a panel on laser technology development. Could one of you kind of give a short overview of where we are in that program?
Jay, maybe you could, or Roger?

GENERAL GARNER: We're doing two things in lasers. First of all, we're doing a very low level of funding in laser comms, and I think there's a big payoff in laser comms because if you can do that, you get the kind of pipes you need to do a lot of things. The other we're doing is we have a fairly large laser facility at White Sands we call HELSTAF that the Army unfunded because of resource implications, not because we didn't want to do it. We unfunded it two years ago and that money has been put into it at about $25-26 million a year by the Congress ever since '93 and Congress continues to fund that.

We're right now working at White Sands with the Israelis on a small project called Nautilus to see what is the ability to weaponize lasers to do some missile defense work. We'll finish that in '96. The degree to which we answer that problem will determine how much further we go in that. The Israelis are very interested to attack the 122 problems they have right now, the Frog problem, and other problems.

We're kind of interested in it because if it works, it's a cheap kill against cheap rockets. Right now as we try to kill rockets in flight, we use an awfully expensive system to do that. It's not a cost-effective trade-off.

So if Congress lets us, we'll probably close our MIRACL laser in '96. Then if there's any weaponization that comes out of the work we're doing with the Israelis, and I kind of think there may be, we'll continue on a smaller level on the weaponization of high-energy lasers. But that's the tactical stuff, not really the strategic stuff.

GENERAL ASHY: Thank you, Jay. For Mr. Harris, a question about what ARPA is doing with reconnaissance. Will it dilute or take away or add to or how will it interface with space-borne collection? How are we integrating those two efforts?

MR. HARRIS: In my previous job, I was instrumental in the establishment of the DARO because it's an important capability to be able to integrate the strength of airborne reconnaissance with the strengths of space-based reconnaissance, and they are without question complementary. In the stand-up of the DARO organization, we have worked very closely with General Israel to make sure that the two pieces fit together and we have co-located both offices together, the National Reconnaissance Office and the Defense Airborne Reconnaissance Office into the same physical office spaces at the Pentagon to try and ensure that communications are taking place and we can leverage each of our architectures. We have published an Integrated Program and Technology Plan that General Israel and I have both signed up for. So I think we're off to a pretty good start there.

GENERAL ASHY: Thank you. Gil's got to leave here in three minutes. Before he does, one last question,

just sorting through all of these. And I think we can all address it. Can you give us the big picture perspective on shared warning and it's importance to stability in working with our allies?

MR. KLINGER: I think shared warning is an example of one of the places that we were talking about earlier that we have capabilities already in existence and we'll have more in the future. Capabilities that are fairly unique, quite apart from the systems that Russia has where we can offer a service to our allies, a service that is critical to them. More critical at any given moment than they are to us with the end of the Cold War. Because if you look at the map, Africa and some of the more unpleasant actors in Africa are a lot closer to Europe than they are to us. And this simple fact is not lost on our French, Italian, British, and Spanish allies, judging from some of their comments two weeks ago when I attended the Western European Union Meetings in Grand Canary Islands. While some of them were berating us about dominating the market in a one-way competition, they also are rather interested in what we have to offer in terms of early warning and what do you get out of this.

Well, a number of things. First of all, to the extent we increase our cooperation on early warning both within NATO and on a bilateral basis with some of our other allies, you are guaranteed to increase interoperability. To the extent that those services are provided in return for arrangements that are either financial in nature or of some other type, we get benefits and leverage at a time where are own resources are diminishing. We further have the capability to make the path for cooperation in other areas. In other words, to the extent that an otherwise reluctant partner of the United States discovers to their pleasant surprise that we are a reliable partner, capable of providing services that otherwise are not available but are nonetheless crucial to that country's national security, it's going to open the door to some other cooperative ventures in the future. So I think it is a win-win proposition all the way around and what we're working both within NATO and on more bilateral basis is how do we get from here to there. How do you go, as Jeff put it earlier, how do you go from the notepad to the actualization of those capabilities?

GENERAL ASHY: Gil, you're going to have to leave, so I'd like everyone to join in thanking you for coming and have a safe trip. Really appreciate it.

Building on what Gil just talked about in terms of shared warning, we've got several questions here and I'm trying to wrap them all up. I'd like our panel members to address some specifics about service contributions. It's important that we address shared warning. The notion of stability and deterrence is what we're about here, and we, in the Unified Command, have been tasked to put an operations concept together. We have the capability now. So what we tried to do is construct a system and propose it in our concept to General Shali and the Joint Staff and the DoD staff where it's flexible enough so that as the political and policy decisions are decided upon, that you can take this pipe of shared warning, (I'm talking about space-borne warning), and do what you want to with it in continence with the policy. So that's basically the concept we have proposed using the Tactical Events System we talked about. I'm going to ask Jay to talk a little about JTAGS and Roger to talk about ALERT in that regard. But, the point is that we have improved the tactical events warning capability drastically since Desert Storm. I can't go into a lot of detail about it, but we have focused quite a bit on it. We have the system in place, and from the U.S. Space Command and NORAD perspective, we are going to follow up at my level, the joint level, the U.S. Space Command level, and not encumber the flow of data to the theater commander. But we're going to back it up and make sure it's correlated and it's correct and fulfill our responsibilities in reporting events around the world to the proper authorities. So that kind of covers the policy, the concept. Perhaps, Jay, you could give us a short burst on JTAGS. It's working well, and maybe you can tell the audience where it is and a few particulars about it.

GENERAL GARNER: We're going to, our plan is to have five JTAG systems. We currently have one in Europe and we just put one in Korea. The one in Korea is at OSAN. It's being tested right now and it's doing very, very well. We direct down-link JTAGS right into core headquarters. We also put it right directly into the theater missile defense tactical operations center that we have here in ARSPACE that deploys to whatever contingency we have.

So JTAGS is working real well. What it does, it gives right now within about a 15 square kilometer box—and most times a little smaller than that—where a launch came from. That allows us then to cross queue whatever sensor we have, perhaps a UAV into there. We've already gone through a little bit of IPB and canceled out to the terrain in which the class of missiles we're fighting can't deploy in. So that makes that box a little smaller and narrows the search. So what we try to do is get a sensor in there as fast as we can; find the guy; track him back to his lair if he moves; or if he stays right there, kill him. If he moves, track him until he gets back to the lair and kill him in his lair.

And then it gives us a box in which impact is going to occur. That varies in size but it's always pretty large. What we need to do with JTAGS in the future is get the box that shows where a launch occurred from down much smaller, and get the point of impact more precise. The problem we have right now occurs with warning. We know when launch occurs, we've got a general idea where the impact's going to occur, so we want to warn the affected units. The problem is we have to go through so many common

nodes that you can't get through in time, so you end up warning the whole theater. What we have to really do is work on the warning problem so we can do discrete warning and get it right down to Charlie Company of the 52nd Infantry and tell them you'd better mop up because one's coming in.

From where we are right now in the state of the art of JTAGS, we're doing real well. We will have two JTAG systems here in Colorado Springs; we'll probably have a third one at Fort Bliss where we teach the crews.

GENERAL ASHY: Thanks, Jay. Roger, a little bit on ALERT.

GENERAL DEKOK: Yes, Sir. As I believe most in the audience know, we've gone operational with ALERT locate and report to the theater. Our theater missile warning system is based on DSP technology using virtually the same software that was developed for J-TAGS. The difference is we take all of the DSP sources from all of the various satellites around the world and additional information, and fuse it centrally out at Falcon Air Force Base in the 11th Space Warning Squadron. We've been extremely pleased with the capability that's been developed there. We, very similar to JTAGS, had concerns about the reliability and timeliness of the dissemination mechanism in terms of communications that's used for that, but I believe we have proven to ourselves that we have just about achieved the limit of capability of milking information from the fundamental focal plane of the DSP sensor. And it has been a great improvement in our capability to provide that warning to the theater.

It has also served as a prototype for what we believe will evolve into the ground architecture for the space-based infrared system in terms of ability to fuse information from multiple sources, which I believe is really the promise of the future when we get to theater missile warning.

So we're quite excited about the capability. It's moving in the right direction, and I believe we've established a linkage to the future with a space-based infrared system that will serve us and the nation well.

GENERAL ASHY: A related question. What is the preferred system to direct down-link, as Jay referred to it, in a kind of a centralized hub? Let me try to respond to that.

In continence with our organization, with service components, we have developed systems by component and we have given the theater commanders a choice. Direct down-link or a hub. But in the overall perspective, J-TAGS and ALERT systems are basically the same. They're routed a little bit differently. What we're trying to do, though, from my perspective, is make this a seamless system so that the commander can choose and we give them, no matter how it's routed, reliable, stereo-quality, true, quick information. And so, I think that the Navy, the Air Force, and the Army components would all agree. I think we've made great strides, and Jay covered some of those quantifiable improvements.

So the answer is we're not going to run this thing from Cheyenne Mountain, if that's the genesis of the question. We're going to back it up because, as the unified commander with the components who own these systems, I have to make sure that when we report it, after we do it reliably and quickly and truly, that it's correlated and that the proper authorities are quickly notified.

For Mr. Harris, could you give us an idea of how, in your Air Force hat, are you going to fit into this new acquisition scheme as it unfolds? I know it's probably not been determined, but maybe you have insight into this.

MR. HARRIS: It's clear, as Gil said, that the Department of Defense is struggling to make sure that we fix more than we break in the realignment of space to make sure that all of the citronequities are well protected. And so as the assistant secretary of the Air Force for Space, we're working hard to make sure that the avenues for dialogue are open as we begin to make these changes. We continue to be concerned that we don't add additional bureaucracy to the process that we've all agreed needs to be fixed, and so I think we're all working together to try and make sure we dot the i's and cross the t's properly.

We've decided to hold, with my second hat on, the integration with the National Reconnaissance Office aside for a few months here in order, as Paul Kaminski would say, to allow the process to stabilize a little bit in some of the streamlining steps to take effect within the larger effort. So we're trying to be very helpful in that process to create a framework that will allow for the appropriate coordination to take place with the National Intelligence Systems at a later date.

GENERAL ASHY: Thank you, Jeff. For our military panel members, there's a question about how we train service members on space systems. Could I get you all to maybe give some perspectives on that? How about the Navy? I'm sure you do that through Naval Space Command. Walt, perhaps you could start.

ADMIRAL DAVIS: Space Command serves as our focal point for that, and they work closely with the battle groups as they deploy to ensure that the battle group is able to use to its maximum advantage the existing space systems.

GENERAL ASHY: Roger, how about you? Tell us about Air Force training programs.

GENERAL DEKOK: Yes, Sir. It's sort of a dual program. Much of our basic training and education in space is done by Air Education and Training Com-

mand. Its been well institutionalized with literally thousands of graduates over the years who have gone through our various training and education courses that take our people up through what we call our initial qualification training, which is just short of being mission ready and able to operate our systems. I believe that's well institutionalized. In the past several years we've transitioned virtually all of that capability, some of which used to be organic to Air Force Space Command, to Air Education and Training Command. They're in the process of establishing a space university, so to speak, at Vandenberg Air Force Base. Much of that has been transitioned.

We also have made those courses available to members of the other services. More recently, the Air Force Space Warfare Center has embarked on a wide variety of more operationally oriented training programs dedicated to space tactics and procedures that have been developed under Brigadier General Vesely out at the Space Warfare Center. They vary from a couple of days in duration all the way to almost four months for one of the newer courses, which is our space tactics course. It's an elite course that we've developed for very select individuals which then can be populated throughout the various Air Force elements as well as Unified commands around the world. We're quite pleased with that. In fact, we're in dialogue with Air Combat Command as we work right now, to see if we can even get toward a goal of joint graduation of our courses in order to further integrate space and air operations.

GENERAL ASHY: I need to help frame this question. Since I've been here we've done two operations specifically: Haiti and Southwest Asia again. From my perspective, having been on the other end of this thing, it was very interesting to see what the service components do to contribute to our land and air and sea capabilities to train people and put this stuff in their hands. And it takes some training. There's some wonderful examples in Haiti. I know Jay was in the middle of that. Maybe that'll help you, Jay, with the question.

GENERAL GARNER: We deal with space a little bit different. We see space as something that cuts horizontally and across the land warfare components so we do black space mostly with our TENCAP organization, Army Space Program Office. And most of the training in that is done at Ft. Huachuca because it's mostly intelligence related. And we put those organizations together. They deploy out to our cores and generally speaking, the bulk of those people are trained at Ft. Huachuca, except some of the signals people who are trained at Fort Worth.

Now the other side of that is everything else in space, which is white space to us. And that's done here in Colorado Springs in Army Space under Colonel Paul Semmens and Colonel Bill Hoyman. Those are a variety of people from special operations people to signal people to air defenders to field artilleryman—and they're trained individually in the tradeoff schools in each one of those stovepipes. Then we bring them here and they do unit-type training. So what we try to do is, when we then deploy, we try to make the products that the warfighter gets really invisible to him. He just gets it, he wants this, and he gets it.

When I say war fighter, I'm not talking about a CINC. I'm talking about the guy on the deck of a ship, the guy in a cockpit, or the battalion and brigade commander standing at his tactical operations center fighting the current fight and planning the next fight. So what we try to do, we don't launch into space, we don't fly stuff in space, we do maintain ground terminals and most of those people are taught at Fort Worth, and ARSPACE is responsible for the unit training for that. But what we truly try to do is collect all the things we need coming out of space, force some designs on the products that come out of there, process that in a central place in a contingency team that we have here, and then ship that out to the warfighter and let it really sort of be invisible to him.

ADMIRAL DAVIS: One other aspect that might be worth mentioning, this is not training so much but education. We've really found this pays off. We, as you know, have that at our Naval Post Graduate School. I mentioned to you earlier this Challenge Athena system and our focus is much like Jay's: How do we bring the warfighter what he needs? But in the requirements business it's really essential that people understand space so they can help us use it effectively. That Challenge Athena system that I mentioned to you, that capability, really came through one of our post graduate students who studied this at post graduate school because he understood our need to put together something like that and also understood we need an affordable system and was able to do that. So I think continuing that education, sponsored by the Joint Staff, done at post graduate school but it's sponsored by them, that's really paying off for all our services.

GENERAL ASHY: Perhaps Jeff would like to comment. I see Jeff as a close colleague, but he's also a warfighter and he provides very key services. So the merging of all of this is dependent on what you all have talked about and that's training and educating ourselves out of business in terms of educating warfighters as Jay pointed out. Before Jay talks again, I think Gil spoke about this and from my perspective of being on the other end of this, we need to make it understandable and simple enough that people can comprehend what it is we're talking about, what services we deliver, and, most importantly, who to ask for it. That's why we have space support teams. We have them from the components and we have them from the Joint Staff. I hope sometime in the near fu-

ture we can get out of that business because, as all of the speakers have stated, we will have people out there, warfighters, at all levels to understand this where they don't have to have a team come in and help them. Go ahead, Jay.

GENERAL GARNER: I'll give you a specific Army problem with space, but I really think it's among the services; it's a definite problem in the Army. Like General Ashy said, we've got a space support team. It's general white space, we've got our TENCAPs units in black space, and they deploy every time we go somewhere. And they learn a lot and they bring a lot back, and we do a lot of product improvements and building other things because of what they learn, and we bypass the acquisition system. Means really, if you want acquisition reform, look how we do stuff for today's problems in space. And that is really a good program. It works.

Now at Huntsville, I've got space technologists and they're brilliant. They do great stuff; I mean, they're out there just as busy as little bees doing all kinds of technology. But I tell you what they're doing, they're hobby shopping. Because what we haven't done in the Army is link what we're doing currently in the next two or three years out and how we really want to fight this Army in the year 2010-2015, and said O.K. Based on that what are the architectures up there we need and what are the poles up there we need so that the technologists we have doing these things are really focused?

And that's the bridge that we haven't put together in the Army. Last week I went to TRADOC and talked to General Hartzog. He and I both said we've really been remiss in our jobs because we're doing a great job today and we've got a lot of smart people working tomorrow, but we really haven't given them the concept of the principles of war for tomorrow and the other things. So if you're looking at where something's sort of broken a little bit, it's right there.

So what happens, from my standpoint, you've got a lot of great things going to happen in the future of space, but they're not necessarily driven by the operators because the operators haven't stepped up and said this is how I'm going to fight 15 or 20 years from now and here's what I need. We're getting there.

GENERAL ASHY: To add just a little bit more and we'll get off this question, in the last six months we in the Unified staff have been working very hard on a story that's understandable in a format that's standard. Not that we're trying to over standardize, but we started from scratch and we think we are probably at the 95 percent solution level. We've done this from the Unified staff to the theater warfighters at the joint level and we've given it to our components through the space support teams to say here is the model based on specific examples. Go out there and teach it and give it and work with them and help them. You can't take away from it, but you can add to it and tailor it to their particular needs. So I think we're there, and I'm very proud of that. I think this will add to the understanding.

From my perspective, the people out there want to use this stuff. They just don't understand it because they don't know where to go and ask for it, and I think we've made great strides in that regard.

We have a question from a very distinguished person among us. I'm going to ask you to respond to it. Since the change in the world order, vis-a-vis the former Soviet Union and the change in the possible ICBM threat, why not pursue a general missile defense rather than a specific missile defense and therefore discourage proliferation of missiles to Third World countries?

GENERAL GARNER: General missiles...I don't know what a general missile defense is...

GENERAL ASHY: I think that's the question. Why not go to general vs. theater and or national.

GENERAL GARNER: Well, let me muck around on that a little bit. Maybe I'll come up with the answer he wants.

First thing, I think right now you have to be careful in blending the theater missile defenses into an NMD thing, because if you do that you begin to get them bound by the ABM Treaty, and I think you want to stay away from that as much as possible. And I won't say any more than that. Right now we have to be careful blending the two.

The second thing, what we call national missile defense to us is a defense against ICBMs. But national missile defense to say, the Japanese or the Europeans, could be a theater missile defense problem. We don't have that problem, but they do.

The third thing is then you say, "O.K., what are you doing in national missile defense?" We get in a lot of debates on whether or not there's a threat there. All I can say is there's two scenarios. One's an accidental launch. We've been living with that a long time and it hasn't happened yet, but with the turbulence with the Soviet Union, you could probably say there may be a little bit more increased risk there. I don't know the answer to that.

The second one is a country or a rogue nation or someone that is a potential enemy now or a short time in the future getting the capability of having an ICBM-type missile. The problem we have in the intelligence community, when we look at that we look at countries being able to do things within their own structure and indigenously. We don't give credit for the transfer of components or the transfer of knowledge.

It took this country about 17 or 18 years to build a missile that went from 100 kilometers to 300 kilometers. But once we did all that and all that got out in literature and all those components can be bought, you

have things happening now where the North Koreans go from 300 kilometers to 1,000 kilometers in about 40 months. And now they're going to 5,000 kilometers. So I'm just saying there is the capability to buy knowledge or to buy components and get there much quicker. How much quicker, I don't know.

The question then becomes, if I see a rogue nation doing this, do I have enough warning time that I can go out and put a capability down on the ground that will protect this nation from that? Certainly, if you see them testing, we'll know that immediately. If he buys a whole round, he has instant capability, and I think we have fair knowledge that that's what going on, but that's no guarantee. If he's buying components or scientists or something like that, that's sometimes virtually impossible to know. And it varies by region. So I don't know the answer to national missile defense. I say, look, if you're worried about it and you're worried about our vagaries of being able to have enough knowledge on another country's capability and it's worth $3-4 billion to you, you ought to go do it.

Candidly, the problem the services have is none of the services want to be the bill payer for that because we're all hurting big time. None of us have enough money to modernize our future force. So I don't know that we're resistive to it, we're just worried about where the money comes from.

I don't think that answers your question, but I don't think until you solve the treaty stuff and you do the right negotiations you can go into a general missile defense, and right now I'm leary of blurring the two together. I think we'd miss a lot of capability on the lower end of the spectrum if we do that.

GENERAL ASHY: But missile defense, I know you would agree with this because we've talked about it, missile defense is missile defense and we've got to address it.

Ladies and gentlemen, that was the last question. I'd like to thank Mr. Harris and our other panel members for being with us. I'd like to thank all of you in the civil and commercial sectors for your partnership and your support. I'd like to thank the Foundation. I'd like to thank my colleague, Dave, thanks a bunch, and all of you for being here. Thank you very much.

DAVID PAYNE: I'd like to thank the distinguished speakers for their candor and their insights and their dedication to America's future. And a special thanks to General Ashy for moderating this session.

The yellow forms out there are surveys, and if you would care to fill those out for the Foundation, we've got some boxes in the back or you can hand them to me or any of the volunteers.

Our next event is our luncheon, and this is co-sponsored by Spectrum Astro and EOSAT with the Space Foundation. The speaker at the luncheon, we're very lucky to have the Honorable Sheila Widnall, the secretary of the United States Air Force. If you go ahead and exit through the back doors and go across the hall, there's some alphabetical listings where your seating arrangements are. We will reconvene here at 1:30 promptly. Thank you very much.

Luncheon Presentation

Featured Speaker: **The Honorable Sheila E. Widnall**
Secretary of the Air Force

Most of you think I came here today just to speak at this luncheon. While that is true, there's another reason I'm here. As many of you know, we're in the middle of a huge Pentagon renovation. My office happens to be in Wedge 1, which means we're the first to move out. They say we can move back in about 10 years, so I'm relocating the entire Air Staff here to the Broadmoor Hotel. (So much for wishful thinking!)

I am excited at the opportunity to speak to you today because I have lots of good news concerning the space business that should interest you all. As many of you know, last year I announced three goals in the space arena:

First, make space support to the warfighter routine.

Second, improve military cooperation with civilian space efforts.

Third, make space launch routine and affordable.

Today I want to give you a progress report on how the Air Force is doing toward reaching the second and third goals. I'm going to focus any remarks on commercial cooperation and space launch because launch vehicles, particularly the commercial launch vehicles, promise the highest dividend for America.

This will be an easy talk for you to listen to, because you only have to remember one thing. That one thing is that the Air Force has officially ended the study phase of improving our space launch situation, and we're aggressively pursuing the action phase.

The reason for my focus on space launch is simple: In 1980, America had 100 percent of the launch vehicle market. Today we have 30 percent. I'm going to do my best to make sure 1995 is the year we start to reverse this trend! Reversing this trend will require a national effort and tremendous cooperation between the Air Force and the commercial space launch industry. Without a cooperative national effort, the trend I just mentioned will not improve.

The good news is we already have an incredible amount of cooperation between the Air Force and commercial space at our launch sites.

Amount of Commercial Activity at Cape Canaveral

Some of you may have heard me talk about the new California Spaceport at Vandenberg Air Force Base. I'm happy to announce that several weeks ago we signed a 25-year lease with the Western Commercial Space Center. They plan to build facilities to launch a variety of small commercial launch vehicles.

However, the lion's share of Air Force interaction with commercial space occurs at Cape Canaveral. In fact last year was a historic transition year for space launch in Florida. In the past, military space launches significantly outnumbered commercial launches. However, in 1994 for the first time ever, the split was 50/50. In fact, three out of three Atlas II launches and one of three Delta launches were commercial. These launches supported Intelsat, DirecTV, and Galaxy.

1995 will be first year commercial launches actually outnumber military launches.

1995 will be first year commercial launches actually outnumber military launches. Of 11 Atlas launches, nine will be commercial. Of 19 East Coast missions planned, 12 are commercial. Commercial missions on the manifest include three Intelsats and several other communication satellites.

Commercial launches at Cape will outpace military launches for the rest of the decade. Of the 111 planned, 69 are commercial missions. In fact, between the early and late parts of the 1990s, the 30/70 civilian/military launch mix will flip-flop, with 60 to 70 percent of EELV launches in the late '90s going commercial.

AF Contributions at Cape

With all this commercial activity predicted for the future, the Air Force is working hand in hand with industry to make access to space easier. In the spirit of cooperation and commercialization, we've made our Atlas and Delta launch pads available to commercial users on a non-interference basis. This cooperation has saved rocket companies the cost of duplicating some very expensive infrastructure.

Additionally, the 45th Space Wing adopted four initiatives to facilitate commercial space. First, they have improved dialogue with industry. Second, they improved the cost accounting system, abolishing indirect costs and unit service charges, and they are evaluating fixed price arrangements. Third, they are simplifying procedures by standardizing and reducing documentation requirements. Finally, they are allowing civilian use of government facilities which are excess to our needs.

Also, our Range Standardization and Automation (RSA) program is investing over a billion dollars to lower operating costs of ranges, modernize utilities, fix roads, and upgrade range infrastructure. The good news for the commercial space industry is that every

time we spend a dime upgrading our infrastructure, commercial space wins since it will be an extensive user of the range.

Historical Context

But perhaps the most important contribution the Air Force can make is our Evolved Expendable Launch Vehicle program, more commonly known as EELV. I think the best way to begin the discussion of the EELV program is to put things in a historical context. Not too long ago, America was the free world leader in the launch vehicle business. The biggest customer was the U.S. government, whose business practices and priorities are fundamentally different than commercial practices. One only has to look at commercial launch practices regarding insurance, risk aversion, and launch operations manning to see stark differences.

As most of you know, our boosters are ICBM derivatives, not "clean sheet" commercial spacelift vehicles. The trade-offs we made back in the '50s to deliver warheads 4,000 miles away with precision are probably not the same trades we'd make to develop an affordable spacelift capability.

Additionally, I suppose it's an American aerospace design standard to push for cutting edge technical solutions which add performance only at the margin at significant additive cost. While this is a great philosophy when you're designing systems which are essential to the defense of America, it may not bode well for profitability. We are changing this paradigm for the EELV program.

Let me give you one example. Some of our rocket engines, like the shuttle main engine, operate at the upper limit of performance. We achieve this outstanding performance by hand tooling, exotic materials, and customizing each engine. The trouble is that last 10 percent of engine performance costs us a lot of money. In the launch vehicle business, we have never designed to cost. Likewise, we have never designed for the express purpose of launching commercial satellites. Unfortunately there is someone who has!

Impressions of French Guiana

I had the opportunity to stop by the Ariane launch facility at Kourou, French Guiana, a few months ago. I saw what the French do and was very impressed by the launch vehicle processing streamlining.

The question is, what can we do? How do we make it more attractive for our own satellite builders and buyers to launch American versus going off shore? How do we make it simpler, less costly, better? Let me give you an example. When the French were designing the Ariane 5, they selected their rocket engine from proven technology, not nearly as complex as the Space Shuttle main engine. The French didn't want to spend scarce development dollars pushing the state-of-the-art rocket engines, when an existing one met the requirements at minimal risk.

There's a lesson to be learned here. Although the Air Force will be designing a new booster to meet Air Force requirements, we must factor commercial requirements into our trade studies. Just as the European Space Agency realized, we too must reduce launch cycle times and minimize manpower. We must break that American paradigm of choosing the most technically elegant solution and instead choose the most cost-effective solution.

There are certainly differences between Ariane and the Air Force. Ariane had a 12-nation consortium subsidize the development costs of the booster and launch facilities. In fact, in Norm Augustine's recent interview with *Aviation Week*, he said, "One has to be very concerned about the future of any industry where your competitors are governments, regardless of the business you're in." Although the Air Force is only one agency of a single nation, we're certainly doing our part to build a world-class launch system.

We must break that American paradigm of choosing the most technically elegant solution and instead choose the most cost-effective solution.

There's another important difference. Ariane has one launch pad, one launch team, one launch vehicle production, and one range. We have 11 launch pads, five launch teams, three launch vehicle production, and two ranges. I think these metrics confirm General Moorman's conclusion that there is overcapacity in our launch vehicle business. If we're successful in the EELV program, we should be able to focus our capacity and put this country back on track toward the top in the launch vehicle business.

EELV

The central question then is how will the Air Force's EELV program improve America's competitiveness in the international launch vehicle business? Let me answer that question with two important points:

- One, we're not just building a booster, we're building a system.
- Two, we're not just building an Air Force system, we're building an American system.

The EELV system will be a national resource, equally viable as a commercial or a military booster. And we're designing and building this system with Air Force budget, infrastructure, and personnel.

Don't get me wrong. The DoD is not financing unique commercial EELV requirements. But we certainly won't stand in the way of the winning EELV builder offering the EELV family to the commercial

market. Just as in the case of commercial Atlas or commercial Delta, the only difference between the commercial and military markets is capacity, not configuration.

Depending on what angle you look at it, the EELV program is either building a commercial booster the military can use, or a military booster the commercial industry can use. This unique aspect of the launch vehicle industry makes it the epitome of "dual use technology."

The primary objective for the EELV program is to reduce total cost for medium and heavy space launch vehicles. One way is to build the system to commercial standards, minimizing military specifications and paperwork.

Another big challenge will be to build something that is responsive to commercial cycle times. Typically, commercial users want to launch on schedule, since time is money. Conversely, military users want to launch on need. Currently we achieve a 50-day cycle time for Atlas, a 28-day cycle time for Delta, and somewhat longer for Titan. We must achieve 30 days or less for EELV.

I'm happy to report we are making good progress on EELV. I was briefed on the acquisition approach several months ago. We're hoping to put the RFP on the street soon, and award multiple contracts this summer. We plan to downselect to a single contractor teams by the end of 1997. We are minimizing government specs and standards, maximizing commercial performance standards and specs, and conducting frequent and early discussions with industry.

In the report we are about to send to Congress, we said our biggest concern for this program was whether we had enough money for this program. Let me say for the record, it has to be! You know the likelihood of the Air Force receiving more money as well as I do, so you must also know what a high priority we'll assign to affordability. We need proven technology, without a lot of cost risk.

I have confidence in American ingenuity to figure out how to improve U.S. competitiveness while staying within this cost target. After all, we had over 600,000 folks in uniform in 1986—now we have 400,000. If we can figure out how to execute an expanding mission with only two-thirds the manpower, we ought to be able to figure out how to build an inexpensive booster!

NASA Reusable Concepts

Now I know when it comes to the question of how to build a cheap booster, there are two camps—expendable and reusable. I've read several interesting articles concerning the merits of reusable launch vehicles. And the engineer in me would love to see reusable launch vehicle technology come up with a breakthrough that makes getting to space inexpensive.

However, I'm also the Secretary of the Air Force with a duty to make sure we have assured access to space. In my opinion, the national space transportation policy signed by President Clinton has the correct answer—we need equally viable expendable and reusable launch vehicle efforts to cover our bets for the future.

I don't want to repeat the mistake we made in the early '80s of having all our eggs in one basket. That's why the Air Force is vigorously pursuing the EELV program.

. . . the EELV program is either building a commercial booster the military can use, or a military booster the commercial industry can use. This unique aspect of the launch vehicle industry makes it the epitome of "dual use technology."

That's about all I have to say on the launch vehicle front, but before I close, let me quickly mention two other items. I know everyone here has heard of information dominance, global presence, and the contribution of space in the information warfare business. An Air Force Space Command blue ribbon panel on space in the 21st century reported that: "Information dominance can only be achieved through the control and exploitation of space, which in the 21st century will be the prerequisite for victory in surface operations."

A key program to help us achieve information dominance is our new space-based infrared systems. I'm happy to report that we've also managed to get this program out of the study phase and into the action phase. This program, like the Defense Support Program, will provide all joint warfighters the earliest warning of ballistic missile attack.

This will be a streamlined acquisition similar to EELV. The RFP went out in February; we just received several proposals, and we plan to award contracts this summer. This program has additional significance because we recently signed an agreement between the Air Force and NRO for unprecedented cooperation. SBIR is truly an integrated, national program!

Space Management

The other item I wanted to touch on is the progress we've made in the space management arena. The Deputy Secretary of Defense recently approved Deputy Under Secretary of Defense for Space Reporting to Paul Kaminski. He also agreed to form a DoD space architect office within the Air Force reporting to the Air Force Acquisition Executive. Eventually, we plan to merge the architect functions for the DoD and NRO.

This has been labeled a congressional issue, a roles and missions issue, and a reinventing government issue. A few have questioned Air Force motives, and

whether or not we can be trusted to satisfy other services requirements. I say let the following facts speak for themselves.

The Air Force spends $6 billion dollars of its TOA on space. We're using our TOA to satisfy the joint warfighter customer. We buy boosters to launch AF, NRO, and Navy satellites. We build communication satellites that carry Army, Air Force, Navy, and Marine messages. Seventy percent of the MILSTAR satellite capacity, which we funded entirely out of the Air Force budget, carries messages to Joint Task Force ground commanders. We buy space-based infrared satellites to warn soldiers, sailors, marines, and airmen of incoming SCUD missiles.

With $6 Billion of extra TOA per year, we could buy more B-2s, accelerate the F-22, and deliver the C-17 faster - but we don't. We believe space is a core competence of the United States Air Force, and we put our money where our mouth is.

Conclusion

The launch vehicle plans, space-based infrared satellite program, and the space management issue are all contentious issues we've faced since I arrived at the Pentagon. I'm happy to report we have made great progress in resolving them. In case you haven't noticed, I'm the strongest advocate for space in the Department of Defense. I truly believe space is one of the Air Force's core competencies, and I will continue to do my best to ensure the Air Force provides the best space capabilities to the joint team.

The World Is Into Space

Master Moderator: **David L. Payne**
Manager, Spacecraft Technology
TRW Space & Electronics Group

Introductions: **General James E. Hill**
U.S.A.F. (Ret.)

Keynote: **Daniel S. Goldin**
NASA Administrator

The Hon. Robert S. Walker
Chairman, Science Committee
U.S. House of Representatives

Session Moderator: **Dr. Brian Dailey**
Vice President,
Business Development/Washington Operations
Lockheed Martin Space & Strategic Missiles Sector

Speakers: **Lionel "Skip" Johns**
Associate Director for Technology
White House Office of Science & Technology Policy

Dr. Edward Stone
Director
Jet Propulsion Laboratory

Jean-Jacques Dordain
Associate Director, International Affairs, Strategy & Planning
European Space Agency (ESA)

John W. O'Neill
Director of Mission Operations
NASA Johnson Space Center

Chen Baosheng
Chief Executive Officer
China Great Wall Industry Corporation

Dr. Roland Doré
President
International Space University (ISU)

Lon Rains
Editor
Space News

MR. PAYNE: We have an excellent afternoon session, and it will celebrate the world as a space-faring planet. To introduce Dan Goldin, it's my pleasure to introduce General Jim Hill.

GENERAL HILL: Thank you, Dave, and again I welcome you to this session of the 11th National Space Symposium. In April of 1992 Daniel S. Goldin became the ninth NASA administrator and immediately established himself as a leader for change by bringing reform and revitalization to America's space agency. Mr. Goldin has focused on streamlining the agency and creating a more business-like approach with budgetary reforms and the best establishment of the "faster, better, cheaper" philosophy for space. Under the leadership of President Clinton and Vice President Gore, Mr. Goldin has been boldly promoting cooperation with his counterpart Yuri Koptev of the Russian Space Agency.

Prior to assuming his current position, Mr. Goldin was the vice president and general manager of the TRW Space and Technology Group. During his 25 year career at TRW, he successfully managed the development and production of numerous advanced spacecraft and space instruments. Mr. Goldin began his career as a research scientist at NASA after graduating with a bachelor of science in mechanical engineering from the City College of New York. It is my distinct pleasure to introduce one of the world's great champions of space, Mr. Dan Goldin.

I'm going to take you on a trip to the future—to the year 2020. I'm going to give you a picture of where the world could be in space.

MR. GOLDIN: I'm going to take you on a trip to the future—to the year 2020. I'm going to give you a picture of where the world could be in space. I want to talk about the brilliant and the breathtaking, because that's what the world is capable of.

If there was any doubt about the miracles the world can do in space, they were put to rest two months ago. In a celestial ballet that riveted the world, in February, the Shuttle came within a wing's length of the Russian Mir space station. This was a miracle

of technology and a powerful symbol of the new trust between the United States and Russia.

It's a trust we've helped build through cooperation in space. This trust—and the trust we've built with all of our international partners—is going to open a new era in space. A new era in international cooperation. A new era in science and technology. A bold new era in exploration.

But before I lay out a vision of where the world could be in the future, I want to tell you why there is a vision at all. You see, I think it's easy for us to get caught up in our own ideas and excitement about space. We can forget what's behind it all. We can forget the real reason for any space policy or program.

It's for the children, plain and simple. It's for the next generation, who will lead the world into the new millennium. Boldly expanding the frontiers of space, and driving the science and technology it takes to get there, is one of the most important investments we can make in our children.

In every spacefaring country in the world, people say, "How can we talk about doing things in space—going to the moon or Mars or a comet or an asteroid—when people are starving?" Of course the world needs to take care of its people. They need food, shelter, health care and many other things.

But they also need a future of hope. The world's children will need the technologies, science, jobs, industries, international skills and inspiration that flow from the exploration of space. These skills and benefits aren't luxuries. They're essential to success in the 21st century.

I'm going to give you a picture of how space exploration could touch the world in the year 2020. Let me take you on a fantasy trip and talk about what might be.

In the year 2020, the Mars 2 crew has just returned. They've come back to Earth and home to their respective countries. The crew commander is holding a press conference to talk about some of the astounding findings from this three-year journey.

As the crew commander steps up to the microphones, the world, and the world's children, watch. She begins to speak. She has some incredible news. Her crew brought back some core drillings and rocks from the ancient lake beds of Mars.

When they first surveyed the area, they couldn't find any signs of life—just like the Viking mission. But the astronauts learned something from scientists in the 1990s, who cracked open the rocks of the barren Antarctica and found lichens. The astronauts cracked open the rocks of Mars, took out their microscopes, and found something amazing, too.

They found fossils of elemental cells. We reconstructed these cells in a lab and found elements of proteins similar to what's on Earth. These are the building blocks of life. This is exciting because we'd also found something similar in comet samples. Now we're beginning to speculate that there was a comet flood on Earth and Mars simultaneously, which carried basic proteins—the cosmic soup.

For the first half billion, or billion years, Earth and Mars had a similar evolution. Elemental forms of life developed on both planets. But we didn't get this connection until now, the year 2020. We didn't know where that first elemental cell came from until the astronauts found it on Mars.

Imagine it. These astronauts have unlocked one of the secrets of creation. The children of the world have a new connection with their universe, and new knowledge about the origins of life.

Imagine it. These astronauts have unlocked one of the secrets of creation. The children of the world have a new connection with their universe, and new knowledge about the origins of life. They have a context for life and for themselves no generation before has ever had.

The decision to go to Mars also brought the world practical benefits.

Space agencies had to develop revolutionary systems to get to Mars. The astronauts were gone for three years altogether. We had to develop systems that could keep the air and water in their rocket clean and life-supporting.

These systems have had a tremendous effect on Earth. Knowing how to filter out impurities in water and air has given us a much cleaner, safer environment.

Some of the systems we developed to purify and recycle liquid aboard the international Space Station, and then on the trip to Mars, are now used on Earth. They're used throughout Alaska to protect permafrost and tundra and to provide a more robust sanitary system there.

Space agencies also developed incredible medical systems. Our astronauts couldn't take hospitals or doctors with them to Mars. So we developed chemical surgery techniques that could heal sick astronauts without scalpels or incisions. We put micromachines into their bodies that doctors could manipulate from the ground.

Way back in 1995, these little machines were only a concept in the minds of engineers and scientists at space agencies and research institutes around the world. Today, they can monitor what's happening in the body, and carry antibodies directly to a certain part of the body. Or go directly to where a medical problem has begun and resolve it.

That means that here on Earth, medical care is more accessible, less expensive and less intrusive than it's ever been. The same kind of vital sensors we put into the bodies of astronauts to monitor, diagnose and treat them from the ground are used throughout the world. They can monitor a person's health and vital functions from a prenatal period to old age.

They're used by surgeons to make prenatal corrections. They're used to continually monitor the elderly. If something goes wrong, a doctor is on the phone or another interactive system with a patient within minutes. People in remote villages around the world now have access to high-quality health care. We are diagnosed and treated in our homes. A hospital stay is the exception.

And here's the connection with the world's children. Young people across the globe helped us design these medical and life-supporting systems and test them. University students wrote proposals for NASA and other space agencies, working in collaboration with their peers across the globe. Junior high and high school students ran experiments on closed-loop systems, testing air and water purity. Elementary school children collected data on the heart rate and vital signs of the human subjects in these experiments.

They were doing real research with a real purpose. These children had a stake in the trip to Mars. When the astronauts landed, the world's schoolchildren felt more than the thrill of this moment. They felt a sense of accomplishment and connectedness. They helped make it happen.

Scientists and students learned much of what it took to get to Mars through the international Space Station. It was our stepping stone to deep space. It's where we learned how human beings could live and work safely and efficiently in space for long periods. It was the next link in the human adventure in space.

The Station also gave researchers and students long-term access to experimenting in microgravity. The insights and new knowledge gained in the areas of medicine and materials has been astounding. Few things have added to what the world does in science and technology as dramatically as the international Space Station.

The Station is also where the world learned how to work together on complex projects.

Every student in the year 2020 benefits from the new international partnerships that have blossomed since then. Children in science, math, language, history and social studies classes collaborate with their peers from around the world.

It's hard to imagine the loss of all the opportunities the Space Station has given us in the year 2020.

In the year 2020, every freshman engineering student can tell you about the revolution that's occurred in spacecraft design.

Back in the early 1990s, spacecraft were the size of a tractor-trailer. They weighed 40,000 pounds and took a decade to build. But a revolution started in the mid-1990s. Spacecraft were shrunk by orders of magnitude. By the turn of the century, many of them weighed tens of kilograms and cost tens of millions of dollars, not ten times that. They were built on desktops, not high bay areas. We launched dozens a year to explore the universe.

A mother spacecraft would drop swarms of even smaller spacecraft out to measure the environment of a planet, and they'd radio back information.

An international challenge has been issued to increase their capacity. If freshmen engineering students aren't working on it in class, they're communicating with their computers at home. They're working furiously to improve the resolution of spacecraft images, their ability to detect color, and other capacities.

Other spacecraft developed by space agencies are self-healing, like the human body. We had to develop spacecraft that could detect and fix problems. Our Mars crew was too far away to have to depend on experts on the ground.

Another part of getting to Mars was learning how to live off the land. Successful expeditions on Earth lived off the land, instead of trying to take all their supplies with them. The same thing is true in space.

Space agencies launched robotic probes. We extracted resources from the atmosphere and land to build up stores of breathing gases and fuel. We can use this fuel to power our mobile vehicles to heat and cool. We learned how to plant gardens on Mars. All we brought were seeds.

In the 1990s, it took two acres to provide the proper nutrition for one person. It was too costly and too difficult to carry the supplies needed to do that to Mars. So we figured out how to do it in tens of square meters instead. And these crops are much more productive. They have more nutritional value. Vegetables can provide the full value of amino acids.

Every child in the world has reaped the benefits of the new reusable launch vehicle. This is what made the development of space affordable. It opened up the heavens to space exploration and commercial utilization. Now, of course, there is a constellation of outposts in space, built and operated by international partnerships of industry, governments, and university students and faculty.

In 2020, students are doing such sophisticated environmental monitoring that their data is no longer fed into a central system for scientists to use. It's part of a distributed system that's used by policy makers around the globe. School children don't just have access to global environmental conferences. They participate. They present their findings, models and proposals.

This worldwide program has its roots in the GLOBE program. That was one of the ways NASA invested in America's children in the 1990s. Back then, it was a national program, not an international

one—a joint effort by NASA, NOAA, EPA and other agencies.

Children got to select a plot of land, 30 meters by 30 meters. They put a stake in the ground and claimed it. They measured temperature, pressure, rainwater, ground moisture, pH, and clarity of air. They looked at foliage. And like today, in the year 2020, it was never just an exercise. Those children made a contribution to scientific knowledge back then, just like they do today, in the year 2020.

Imagine that. There may be another life-bearing planet in the universe. This is breathtaking.

Elementary classrooms around the world display a large, glossy photograph. It's a picture of a blue planet with clouds. This planet is circling a star somewhere beyond Alpha Centuri. Teachers point out that because of the color of its oceans, it may be life-bearing. Imagine that. There may be another life-bearing planet in the universe. This is breathtaking.

These children are dazzled. They stand in front of these pictures and see the shapes and patterns, the water and land mass, of this startling planet worlds away from Earth. They wonder what form of life exists there, or if humans will ever live there.

Before NASA and other space agencies took these pictures, we did chemical analyses of this planet's atmosphere. That told us there was abundant oxygen, carbon dioxide, methane and water vapor there. The pictures confirmed that. And because the resolution of these pictures is so high, we can actually see continents.

Let's take a look at an 8th-grade class. The students are trilingual, of course, so it's not easy to tell just by listening what country they're from. As part of their science class, they're operating robots on the moons of Mars with students from their "sister school" on another continent.

If we listen to them talking, we find that they're connected, really connected, to exploration. They're doing it. They operate these robots by remote control. They see what the robot sees, as it moves over the Martian lunar terrain. They're excited. It makes a difference to them.

Some of these children will be excited about science and discovery all of their lives. Many of them will stay curious and interested about their universe. Maybe about other things, too. They'll be hooked on discovery. They'll be open to wonder.

The high school classes of 2020 are also active. They analyze samples returned from comets, asteroids and other planetary bodies, and put the results on the Internet. The science they do gets shared with students and scientists around the world.

You may think I've had a little fun with you this afternoon. You may think all this is pie-in-the-sky. It isn't. The vignettes I've given you—and other ones as well—could really happen.

The international Space Station is the next big step. The Station is what will make possible the human journey into deep space.

NASA is working toward the vision I've described. And we are also getting ourselves ready for the 21st century. We are dramatically restructuring the Agency to be more mobile, agile and responsive. We have five major reviews going on now of our missions, people and facilities. We are examining everything we do.

We're cutting out overlap and redundancy. We're consolidating. We're looking to privatize whatever makes sense to privatize. We are getting back to being an R&D Agency and out of the operations business. We're going to do what we do best, and let the rest go. We're doing things "better, faster and cheaper." We're doing more with less. We're giving taxpayers a bigger bang for their buck than ever before.

Space is vital to the world's future. The technologies we develop to get there, the benefits we bring back, and the international partnerships we forge in the process are the tools of the future. They are tools our children will desperately need to succeed in the 21st century.

In other words, we are revolutionizing NASA. NASA will be ready for the 21st century. NASA will be ready to work with other nations to give the world's children what they'll need in the new millennium.

I don't know what new technologies and breakthroughs long-term access to microgravity will yield. I don't know for certain the technologies we'll gain from sending a human expedition to Mars, an asteroid, a comet, or where ever we decide to go. I can't predict, either, where those technologies will take our children or what industries and jobs they'll foster.

But I do know this. Space is vital to the world's future. The technologies we develop to get there, the benefits we bring back, and the international partnerships we forge in the process are the tools of the future. They are tools our children will desperately need to succeed in the 21st century.

For the last 35 years, we have defined the space frontier. Now, we're going to open that frontier. We're going to do it for the world's children. Children

in inner cities. Children in remote villages. Children of all colors and nationalities. Rich, poor, privileged, hurting—what we do in space can touch the lives of all of them.

Let's give them the technologies, the new industries and jobs they'll need in the new millennium. Let's give them the international skills and partnerships they'll need. And let's give the children of the world one more thing. Let's give them something to hope for, and something to dream about.

Thank you.

MR. PAYNE: I can't wait. That's an awesome vision. We thank you for your visionary comments, Mr. Goldin.

And now we have a special video address from the Honorable Bob Walker, the chairman of the Science Committee of the U.S. House of Representatives.

I believe ultimately that the Space Station will prove to be an extremely valuable laboratory, one in which probably Nobel Prizes will be won when we begin to realize the nature of space and the fact that it is a very different place to do experimentation.

CONGRESSMAN WALKER: Hopefully, coming to you this way will at least give you some sense of where the space program is moving in the next few weeks, months and years. I would like to acknowledge the leadership that Dick MacLeod and his organization show in this effort. They are an extremely valuable asset to us as we go about planning a future that includes a bright future for space activities.

I believe that it's time we recognize that space has to be regarded not just as an item in a $1.5 trillion federal budget, but has to be thought about in light of a $6 trillion national economy. I believe we have an opportunity to begin to think of space as one of those economic frontiers where the United States must not only lead, but must dominate.

To do so, it seems to me we must go beyond just federal spending programs. There are some of those programs that are important, but we need to begin to think about the kinds of tax treatments of space activities that might encourage more people to invest in new kinds of launch vehicles, in new kinds of products made in space.

My efforts are going to extend beyond just the work of the Science Committee because I recognize that there are things that go on in the Ways and Means Committee that have an application to what we achieve in space. I recognize that there are things that go on in other committees of the Congress that have an application. I'm going to try to work with those chairmen and make certain we think of space as a real opportunity for us all.

As I said, there are some things the government does that are very important. We're embarking upon a program to try to build reasonable launch vehicles. I believe those have a chance of dramatically cutting the cost of getting to space. That, of course, would be very appealing to people who want to have a future in commercial space. I also believe that the Space Station is an extremely important part of what we do for our space future. If human beings are to spend long duration periods in space, we've got to learn what that means in terms of life science, and they will be able to do that aboard the Space Station. The fact that we're doing that internationally now with the Russians means we can take advantage of a lot of what they have learned over the last three decades in space and what we've learned in space and combine those two learning curves in a way that benefits both nations. I believe ultimately that the Space Station will prove to be an extremely valuable laboratory, one in which probably Nobel Prizes will be won when we begin to realize the nature of space and the fact that it is a very different place to do experimentation.

I think that's all very exciting, and it's things that NASA can be involved in. But I have to tell you, we're going to be doing this in a very, very tough budget climate, because I am convinced we're going to see a budget come forward by May that will balance the budget of the federal government by the year 2002. To do so, science, space and technology programs will all be involved in the restructuring that will have to take place in government in order to achieve that goal.

I see this as being a year of challenges. Challenges in our space future, challenges to make it work in a way in that we, as a society, participate totally in our space future and do so within the concept of a balanced budget that ensures that our children don't end up paying the bills for what we do now.

It's all going to be very exciting and I look forward to working with all of you as we pursue the goals.

MR. PAYNE: We thank Congressman Walker for taking time in the closing hours of the 100-day contract to provide us with his vision of reality.

It's now my pleasure to introduce this afternoon's chairperson, Dr. Brian Dailey. Dr. Dailey was appointed sector vice president for Business Development in Washington Operations for the Lockheed Martin Space and Strategic Missiles Sector in March of 1995. In this capacity, he has the responsibility for marketing and business development for the sector, as well as managing the marketing and government relations in Washington. Prior to his assignment, he was vice

president of Lockheed Commercial Space Company, where he was instrumental in developing several new commercial lines of business for Lockheed, including remote sensing and space launch.

Dr. Dailey joined Lockheed after serving as executive secretary of the White House National Space Council where he was responsible for formulating and coordinating United States' civil, commercial and national security space policy. Prior to his appointment by President Bush, Dr. Dailey served as senior staff member for the Senate Armed Services Committee.

Dr. Dailey is a graduate of the University of Southern California where he earned a Ph.D. in international relations. Please join me in welcoming our "World Is Into Space" moderator, Dr. Brian Dailey.

DR. DAILEY: Thanks, Dave, for the introduction. And thanks to the U.S. Space Foundation for inviting me here.

This is the first time I've ever had to moderate a panel. I'm actually finding it quite easy. The only thing you have to learn how to say is, "It's 15 minutes or you're dead" to the speakers.

What we have today is a very high-powered panel, and one that I think will provide us with some interesting insights into the key theme of the conference today which is, of course, Vision and Reality. This panel itself, though, is intended to deal with the reality of the internationalization of space and to take a look at the past vision that got us here today. And if possible, I hope, the speakers will try to prepare and propose a vision of where we want to be sometime tomorrow.

Of special interest is a question of whether or not the path to greater internationalization and participation in space will come through such means as the civil space program, or from the apparent aggressive nature of what's taking place today in the international commercial space marketplace—or obviously, a combination of both.

In the former case, the end of the Cold War has brought together former foes and space giants on major international projects such as the International Space Station. This offers the prospect of, among other things, greater pooling of resources to achieve better science and human exploration of space. Also, the exchange of technology and methods to provide maximum leverage of the best of each of the industrial base that these countries can provide. And, of course, by working together, we hopefully promote a better and more stable peace.

Alternatively, or in addition, an area given little notice by many in the past visions of where we would be today, is the role that commercial space will, and is playing, in promoting greater international cooperation. Soon, space goods and services will have a larger degree of international workshirt content, more than what you see today in just simple components, but much more in large scale subsystems. It'll occur, as we're already starting to see, in space launch vehicles, satellites and ground systems. It'll be something to the point where the question of a national system will almost be outmoded, at least in the civil and commercial areas. And of course the possibility strongly exists that we may even see this extended into the military space arena as well.

In short, as the title of the panel indicates, "The World Is Into Space," the discussions today will provide us with some very important insight into that particular area which is becoming more and more international.

What I'd like to do is briefly introduce the panelists that we have up here. I'll start with Mr. Skip Johns who is the associate director of Technology at the White House, Office of Science and Technology Policy; Dr. Ed Stone, the director of Jet Propulsion Laboratory; Jean-Jacques Dordain, associate director of International Affairs, Strategy and Planning, European Space Agency; John O'Neill, director of Mission Operations, NASA Johnson Space Center; Chen Baosheng, chief executive officer, Great Wall of China Industry Corporation; Dr. Roland Doré, president of International Space University; and Mr. Lon Rains, editor of *Space News*.

Let me begin by formally introducing Mr. Johns, with whom I used to work. He has worked previously up at the Office of Technology Assessment and Capitol Hill. He has served there for approximately 16 years and brings to the discussion quite an extensive background in technology and how technology applies to space itself. Prior to joining OSTP, Mr. Johns served 16 years in management of high technology industries. He gained them at the Ocean Science Incorporated, Hazeltine Corporation, the Magnavox Company, and General Instruments Corporation.

He worked on projects involving design development and production of radars, communications, sonar, command and control systems. Immediately upon earning his bachelor of science degree from the University of Virginia, he served as an officer in the United States Navy, as a career-based naval aviator. Skip, it's a pleasure.

MR. JOHNS: Thank you. It's a pleasure to be back with you this year. Last year, during my first symposium presentation, I'm sure you thought that I was a little crazy. Just to refresh your memory, I was asked about the Space Station and whether there was any chance it was going to pass the Congress. I indicated to you we were going to do everything legally possible to make it pass. It took most of that, and a great deal of help on Dan Goldin's part, I might add. It passed by 117 votes. That's not one or two votes, that's 117 votes. So, sometimes a pearl of great price can be had if one works at it hard enough.

I listened to Dan's vision this afternoon and enjoyed it very much. I don't know a lot about the fu-

ture. One has to be careful in forecasting; but I heard one thing that he said that I think I disagree with him on. That is, I think bucks will be bytes, not pucks. So they're likely to be electronic rather than wood.

I appreciate the opportunity to share some of the Administration's views on space with you today. In the short time I have, let me start with the President's own words: "By advancing a program in robotic exploration using smaller, less costly spacecraft, we can further expand our understanding. By renewing our commitment to human space flight in concert with other nations, we can strengthen the bonds of international friendship while fostering the technological development that holds the key to long term economic growth. By completing our Mission to Planet Earth, we will gain unique insight into our planet's dynamic environment. We have one chance to keep our covenant with the generations to come, safeguarding the thin blue shield that sustains all of Earth's inhabitants."

"By renewing our commitment to human space flight in concert with other nations, we can strengthen the bonds of international friendship while fostering the technological development that holds the key to long-term economic growth."—President Clinton

The President made these remarks on the occasion of the 25th anniversary of Apollo 11. There's an awful lot there that goes beyond just Apollo and is relevant for those of us dedicated to this nation's future in space. Let me just highlight what I'd call the main principles and programs underlying the Administration's space policy.

First, we view the space program as a fundamental, long-term investment in America's future. President Clinton believes that a balanced, affordable space program based on revolutionary new partnerships with the private sector and with other space-faring nations is a critical investment in America's 21st century economy.

Second, we're dedicated to preserving American leadership in space. The Clinton Administration supports Dan Goldin in remaking America's space agency to ensure continuing U.S. world leadership in science and technology. NASA has implemented personnel reductions, major management changes to cut costs, reduce bureaucracy and improve performance.

Third, we are revolutionizing the way we conduct space missions, pursuing "faster, better, cheaper" science missions. President Clinton supports NASA's revolutionizing American space exploration by replacing large complex spacecraft with smaller, less expensive, more frequent missions with shorter development times. By fiscal year '99, this new approach to space exploration will allow NASA to reduce average development costs of space science and Mission to Planet Earth payloads from $590 million in fiscal year '90-'94 to $200 million, cut average development time from eight years to four years, and increase yearly launches to an average of eight missions instead of two per year. This means expanding opportunities for the U.S. and the international science community with more frequent missions and shorter lead times to orbit.

Fourth, this Administration has laid the groundwork for focused investments in space transportation. In 1994 we issued a policy designed to enable low-cost access to space. This policy provides a framework for NASA and DoD investments in next generation reusable launch systems and modernization of current ELV fleet.

Last month the Administration announced a cooperative agreement with three industry teams to begin preliminary design work on a next generation launch system which might eventually replace the space shuttle. The program will focus on development of new technologies and operational techniques which will radically reduce the cost of access to space. Again, in an international sense, increasing affordable access to space is something that stands to benefit all of our nations involved in space activities.

The Administration has been at the forefront in supporting the development of the international Space Station as a world-class orbiting laboratory and a catalyst for unprecedented peaceful international cooperation in space.

Fifth and perhaps most relevant to this panel's discussion, we are committed to building the international Space Station. The Administration has been at the forefront in supporting the development of the international Space Station as a world-class orbiting laboratory and a catalyst for unprecedented peaceful international cooperation in space. On more than a few occasions, both the President and Vice President Gore have personally engaged on this issue.

In 1993 the Administration restructured the management of the program, capped its annual budget at $2.1 billion. Since the restructuring, the program has met all costs, technical and schedule requirements, and 37,000 pounds of hardware have been manufactured. Twelve thousand pounds ahead of schedule. In my view, that's a pretty impressive record for such a complex international program.

When complete, the international Space Station will be a world-class orbiting laboratory providing a test bed for technologies of the future and a laboratory for research on new, advanced industrial materials, communications technology and medical research. It will also be an historic symbol of the benefits of peaceful cooperation in space. Following the Administration's lead, the Space Station partners have included Russia in the program, making the station a potent tool for fostering productive cooperation among former adversaries and for promoting world peace.

And sixth, we remain committed to the important exploration of our own planet Earth. One of NASA's most important research programs is the exploration of our own planet. NASA's Mission to Planet Earth is using satellite technologies to monitor the Earth's environment and better understand the world in which we live. This program is giving us powerful new tools for analyzing weather, for long-term prediction of floods, drought, violent storms and other natural occurrences. It is also giving us fundamental new insights into how human activities may also have profound effects on our planet.

In an era of increasingly constrained budgets, not just in the U.S. but also in other countries, international cooperation can and will play an increasingly important role. At the same time, space technologies and applications will increasingly become part of a broader, more competitive global economy. We have seen this evolve in the satellite communication arena and my presumption is that other applications of space technology will follow suit.

Our goal at the national level will be to make every federal dollar count to ensure that the right policy environment to encourage civil, commercial and national security use of space remains high on the national agenda.

Thank you very much.

DR. DAILEY: Thank you, Skip. The next speaker is Dr. Ed Stone, who as I said is the director of Jet Propulsion Laboratory. Dr. Stone is also vice president and professor of physics at California Institute of Technology, Cal Tech. He earned his associates of arts degree in 1956 from Burlington Junior College before continuing his studies at the University of Chicago. After receiving his masters of science and Ph.D. degrees in physics, he joined Cal Tech as a research fellow in physics. Dr. Stone was appointed chairman of Cal Tech's Division of Mathematics and Astronomy in 1983 and vice president of the astronautical facilities in 1988.

Since 1961, Dr. Stone has been the principal investigator on nine NASA spacecraft missions and a co-investigator on five other NASA missions. Dr. Stone has served has project scientist for the Voyager missions of 1972, participating in both hardware development and mission operations. Following the launch in 1977 of twin Voyager spacecraft, he coordinated the efforts of 11 teams of scientists in their studies of Jupiter, Saturn, Uranus, and Neptune, and I think he'll be able to tell us what the future will hold for us.

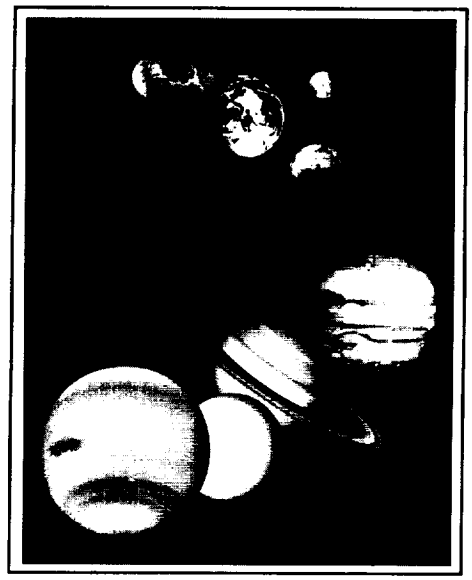

Figure WS-1

DR. STONE: Thank you, Brian. It's certainly my pleasure to be here today. This is a very important time for the space program in the nation and, in fact, in the world. And meetings such as this, I think, are really crucial to helping us all understand what the future should be because space is clearly about the future. In the first three decades of the planetary program (*Fig. WS-1*), we have flown by every planet in the solar system except Pluto, including Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. We have defined the frontier in the first 30-35 years of the space age. Rather than worlds of uninteresting similarity, we discovered worlds of intriguing diversity that beckon our return. Now that we have defined the frontier, we need to open it while emphasizing several critical aspects of the space exploration program.

The first aspect is broader participation so we can focus the best talent in the nation and the world on opening the space frontier. Broader participation means growing participation and partnerships with industry, other government activities, and academia, as well as increasing international collaboration.

A second aspect that will enable broader participation is an increasing frequency of smaller missions with decreasing life cycle costs. I want to illustrate these two characteristics, broader participation and more frequent smaller missions, for the years ahead.

Our next major encounter is with Jupiter employing the Galileo spacecraft (*Fig. WS-2*), which arrives this December. This international mission uses a German engine to slow down and insert the spacecraft into

Figure WS-2

Figure WS-3

orbit. Galileo carries a probe developed by Hughes for NASA/Ames that will plunge into the atmosphere of Jupiter, providing the first insitu measurement of the composition of the atmosphere, temperature, pressure and cloud layers of the planet. The spacecraft will carry out a two-year orbital tour of the Jovian system, flying much closer to the moons of Jupiter than Voyager did in 1979.

One of those moons, Europa (*Fig. WS-3*), is about the size of our own moon but has an icy crust. Europa is of interest because it has the smoothest surface we've found in the solar system. The highest features on this surface are the narrow white streaks that are approximately 200 meters high. It's possible that this is an ice pack on an ocean of liquid water. Galileo will return data from this moon with a resolution that is 100 to 1,000 times better than the very best Voyager data. If this is, indeed, a world with an ocean on it, I can't imagine that we won't return to explore it in great detail because of the important role of oceans in

Figure WS-4

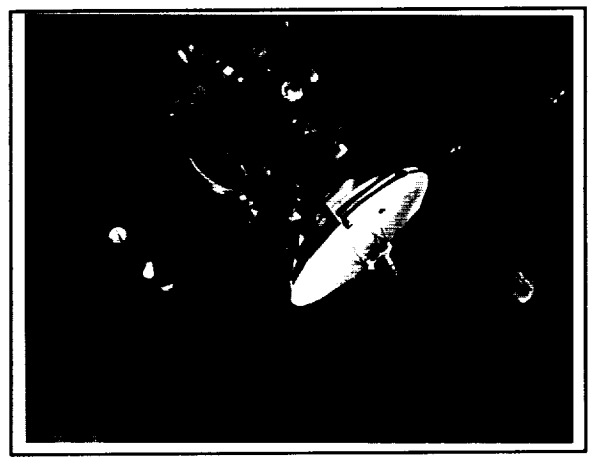

Figure WS-5

the origins of life here on Earth.

Further out in the solar system is another giant planet, Saturn (*Fig. WS-4*), that will be explored by the Cassini Mission to be launched in 1997. Cassini is a joint NASA/ESA undertaking, with approximately 134 U.S. scientists and 120 European scientists participating in the mission. In addition, the Italian Space Agency is separately providing the large dish antenna and the radio system, critical to telecommunications, ring occultation studies, and radar mapping of Saturn's moon, Titan.

The Huggens probe (*Fig. WS-5*), provided by ESA, will be dropped into the atmosphere of Titan, a moon the size of the planet Mercury. Titan's atmosphere, mainly nitrogen with a surface pressure 60% higher than on Earth, contains methane that solar and particle irradiation continuously converts into complex organic molecules. This process may be similar to what occurred on Earth before life evolved. Cassini's Huggens probe will drop into the atmosphere and provide the first insitu measurement of the organic chemistry occurring there. We are anxious to determine whether the organic material raining out of the atmosphere may be forming lakes of organic material on the surface. I

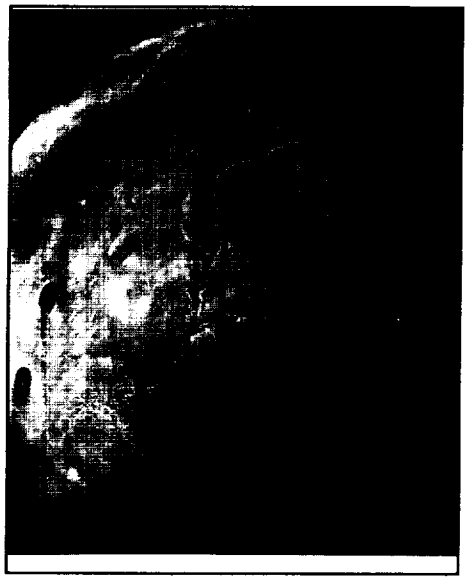

Figure WS-6

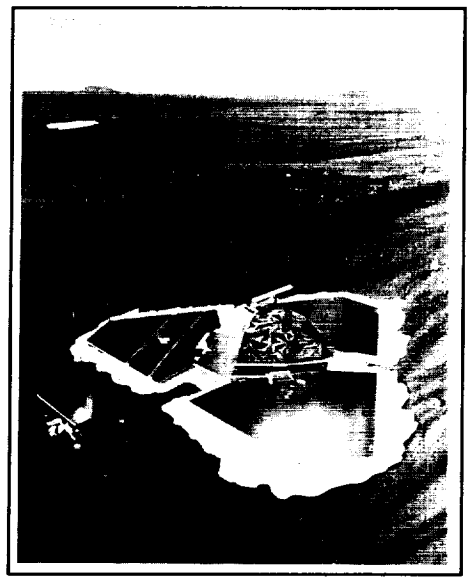

Figure WS-8

Figure WS-7

Figure WS-9

anticipate that we will return to the surface of Titan for further studies of this intriguing world.

A little closer to home is Mars (*Fig. WS-6*), a neighboring planet that we believe at one time had a great deal of water on its surface. A Mars' image (*Fig. WS-7*) shows an old river bed indicating that perhaps 3 1/2 billion years ago there was a large amount of water on the surface. If so, simple life could have evolved and there may well be some fossil evidence of primitive life forms somewhere on Mars.

The small oval in the image is one of the landing sites we're considering for the Mars Pathfinder lander, to be launched late in '96. This site is a flood plain containing rocks washed down from widely spread regions. The material will be examined by a small microrover (*Fig. WS-8*), that is being carried to the surface by Mars Pathfinder. The rover is a miniature spacecraft with a mass of 11.5 kilograms. Using an average power of only 8 watts provided by solar cells, it will maneuver on the surface, using a German-developed camera and an alpha-proton x-ray spectrometer to analyze the composition of the rocks. The main Pathfinder lander will have stereo cameras and a weather station. Mars Pathfinder will be accompanied by a second Mars mission, the Mars Global Surveyor (*Fig. WS-9*), which will use aerobraking to circularize its polar orbit. The Global Surveyor will return maps of the surface of Mars - with resolution of two meters - so we can begin to explore the surface and look for the sites for future robotic surface exploration missions leading eventually to human exploration. The spacecraft is being built by Lockheed Martin and will be launched on a Delta launch vehicle. It is about half the mass of the Mars Observer spacecraft, which was unfortunately lost several years ago.

The Mars '98 Orbiter (*Fig. WS-10*), with a mass of 250 kilograms, is another factor of two smaller in mass than Mars Global Surveyor. Both the '98 Orbiter

Figure WS-10

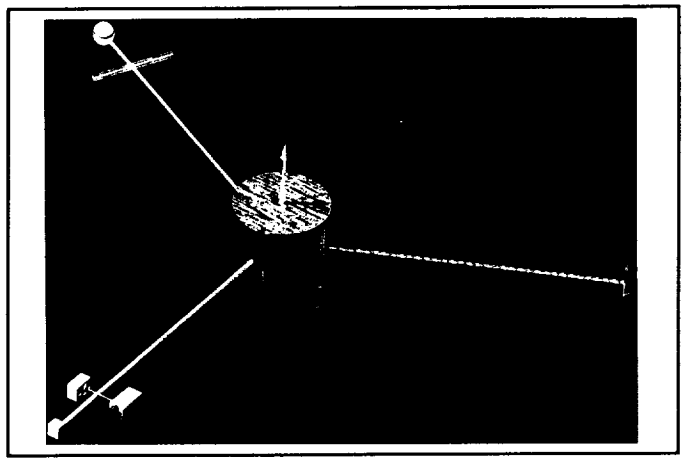

Figure WS-12

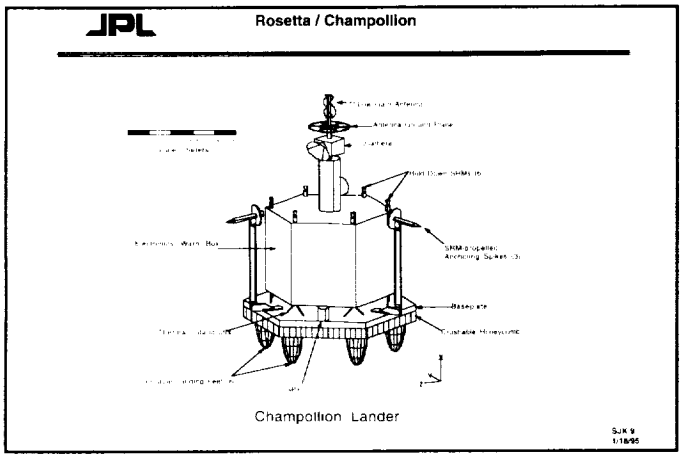

Figure WS-11

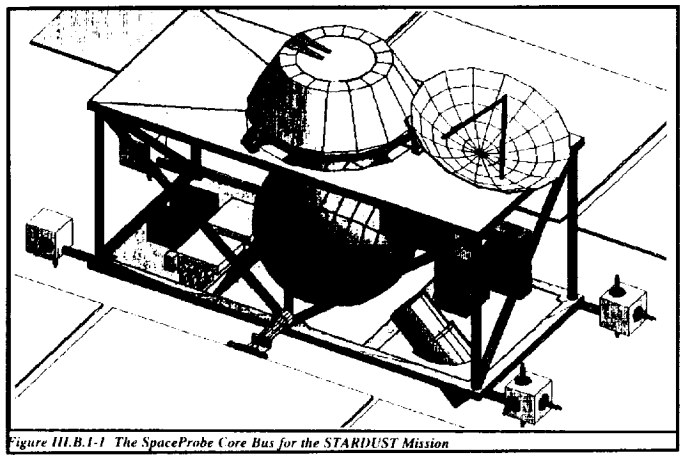

Figure WS-13

and Lander will be built by Lockheed Martin and launched on MedLight launch vehicles. Smaller spacecraft that can be launched with much smaller vehicles will allow us to explore Mars every two years rather than every two decades. That's the "better" of "faster, better, cheaper."

The '96 mission includes a French-developed radio receiver which will act as a relay for the planned Russian '96 mission, providing an important international connection. With more frequent missions to Mars, there will be multiple opportunities for increased scientific return through international collaborations.

The Champollion Lander (*Fig. WS-11*) will be carried by the ESA Rosetta spacecraft on a comet rendezvous and sample analysis mission. Champollion is a joint NASA-CNES development with a tiny 42 kilogram landed package with spikes to hold it in place as it drills into the surface. The sampling depth will reach as much as 100 centimeters so that we can analyze the composition of the organic material that coats the surface of the comets in the solar system. These observations are critical to studies of the origin of the solar system and of the possible role comets may have had in the evolution of life here on Earth.

Figure WS-12 shows another approach to expanding participation in planetary exploration through missions headed by principal investigators. Allen Binder of Lockheed Martin heads the team that will send a small spacecraft (126 kg) to the moon. Following the very successful Clementine mission, Lunar Prospector will carry gamma ray, neutron and alpha particle instruments to map the surface. This mission is the next Discovery Mission after Mars Pathfinder and the Near Earth Asteroid Rendezvous spacecraft being built by the Applied Physics Laboratory and scheduled for launch in February '96.

Three other Discovery missions are in Phase A study; one will be selected. The principal investigators put together the teams with JPL in a supporting role to help implement the mission.

Stardust (*Fig. WS-13*) is a sample return mission with Don Brownlee at the University of Washington as the Principal Investigator. The small yellow container on top will open and out will pop aerogels developed by JPL that will collect comet dust in one case, and interplanetary dust in another. This dust may well be the source of organic material in the solar system and

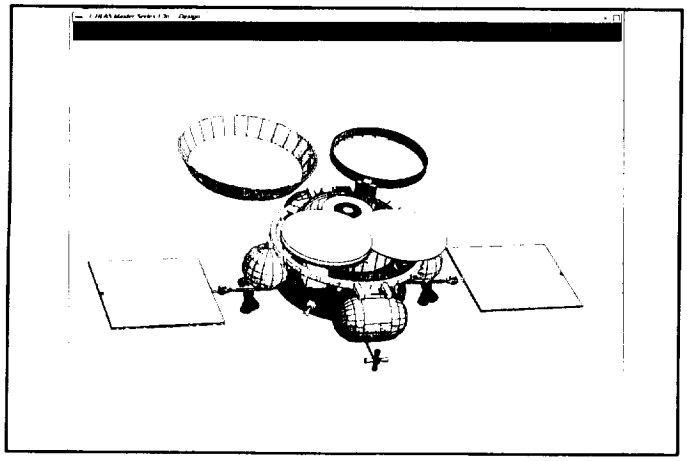

Figure WS-14

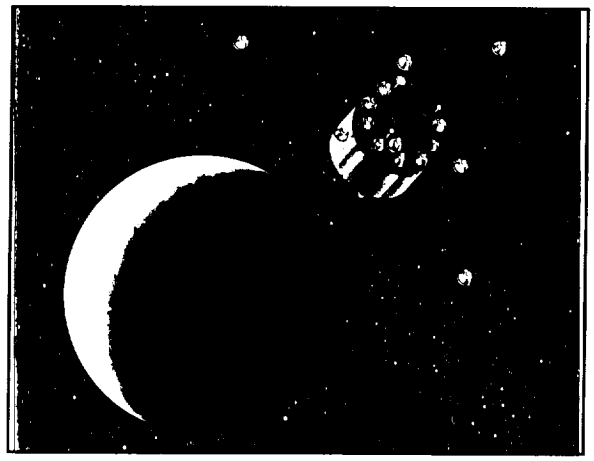

Figure WS-15

these samples will be returned to Earth for detailed analysis.

Another sample return mission (*Fig. WS-14*), Suess-Urey, has Don Burnett of Caltech as the Principal Investigator. Like Stardust, the Suess-Urey team includes Lockheed Martin. The large circular panels on the spacecraft are disks of pure silicon that will capture the solar wind and bring it back to Earth for a precise determination of the composition of the Sun.

Finally, the Venus Multiprobe Mission (*Fig. WS-15*) has Richard Goody at Harvard as Team Leader. Hughes is responsible for developing the system to put 16 probes (25 kilograms each) into the atmosphere of Venus. These are tiny, but capable probes which will be tracked by Very Long Baseline Interferometry from Earth so we can study the cause of the unusual winds on this planet.

Figure WS-16 shows the masses of these and other missions as a function of launch date. Clementine set the stage for the trend toward smaller, more capable missions. The missions which I have described are all in the several hundred kilogram class. We are now in the process of developing the road map for the next step—to go below 100 kilogram missions— the New Millennium class of spacecraft.

We had a workshop at JPL (*Fig. WS-17*) in March attended by representatives from various groups to help us define the key technologies that will enable us to reduce the mission life cycle costs so that more frequent are more affordable. Industry, university, and other federal laboratory members will be selected to participate in each of the five integrated product development teams. Our goals are to develop the technology which will be the key to the next step toward smaller, more frequent missions.

NASA's focus is on expanding the frontiers of space, taking advantage of the nation's capabilities as a spacefaring society and working with international collaborators to do what hasn't been done before.

DR. DAILEY: Thank you. Dr. Stone, what do you see as the role of manned space exploration versus robotic exploration?

DR. STONE: I think they really serve complementary purposes. Human exploration is something which involves human beings going there, and ultimately, there's really no substitute for that, but there's a great deal that can be done with robotic exploration. Concerning Mars, for instance, it is clear that robotic exploration is very important for setting the stage, because human exploration will be much more complex. We need to be sure that when we send humans to Mars, we take best advantage of their capability to explore the most interesting regions. To do this we need to understand Mars a great deal better than we do today robotically before we would want to send the very precious resource of human explorers.

DR. DAILEY: Thank you, Ed, for a great preview of what new science missions we have coming up, and we look forward to the data which it will provide.

Our next speaker is our first component of the international portion of this panel. I have the great pleasure of introducing, Jean-Jacques Dordain. He is the associate director for Strategy Planning and International Policy at the European Space Agency in Paris, France. Prior to that he was a research engineer from 1970-1985 at the Office of the International Institute of Aerospace Research in France. He was also manager from 1986 at the European Space Agency, first as the director of Space Station Utilization and Microgravity Programs and then as director of Strategy.

He is a member of the International Academy of Aeronautics and a member of the European Science and Technology Assembly. Welcome.

MR. DORDAIN: Thank you very much. I am pleased and honored to be with you today, and I am ready to share my views about space activities with you. I

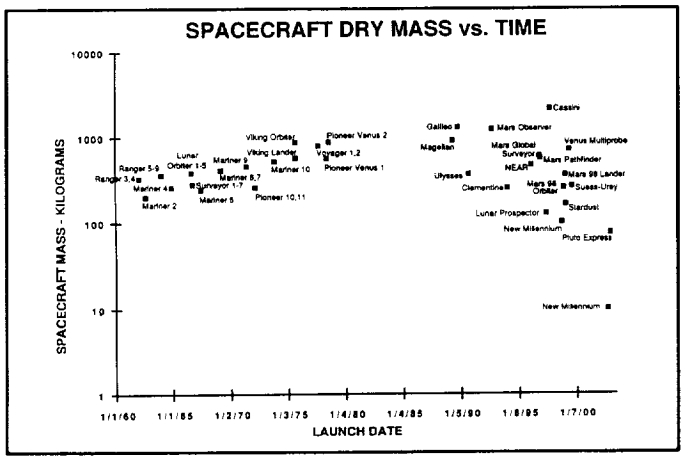

Figure WS-16

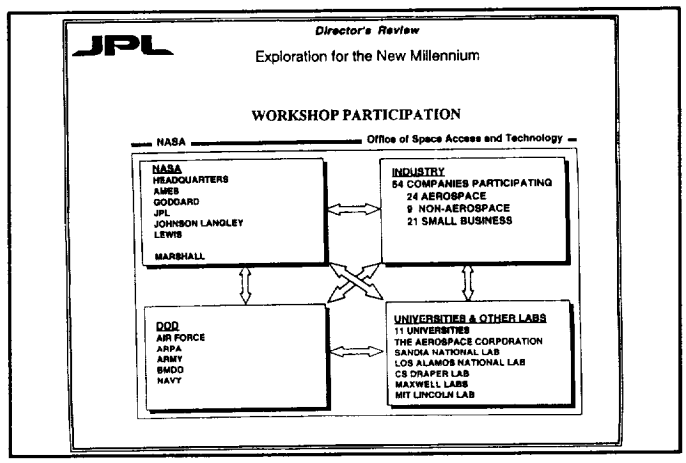

Figure WS-17

would like to say that they are only my views. I have still more questions than I have answers to questions.

As a primary remark, I wish to say that after a couple of years of being in charge of strategy in ESA I have arrived at the conclusion that we, the space agencies, should refrain to propose an overall space policy for at least two reasons.

First, because space is not an objective per se, just a place to run different objectives. Cultural objectives such as improving our knowledge or exploring our universe, strategic objectives such as monitoring disarmament or making foreign policy, and economic objectives, meaning making money.

There is not, therefore, one space policy, but a lot of different policies involved in space utilization: policy of science, policy of telecommunications, policy of environment, etc. The only common points among these policies are the means of access to space and some space technologies.

The second reason why we should refrain to define one space policy is because there is always some suspicion when a space agency proposes a vision. Suspicion that the only objective of such a policy would be to survive.

I shall not propose a global space policy today. And I shall limit my presentation to address some of the key aspects which I believe drive the near future of these activities.

I shall start by the general aspects of the transition period we are all living today. These general aspects are important to understand the programmatic aspects that I shall address in the second part of my presentation.

We are leaving the transition period which mostly represents a sign of maturity. Even though this transition has been disturbed by the political change and the economical difficulties, this transition is a natural process after 30 years of space age, after 30 years of successes. This transition is just a mark of our past successes. We must not, therefore, regret it, we have just to manage it. This transition period ends the first age of space activities. In the first age of space activities we were dedicated to first develop means of access to space. And I would like to recall that thirty to thirty-five percent of the space budgets in almost all space agencies were dedicated so far to access to space; second, to demonstrate the social and economic benefits of space applications; and third, to build up an industrial and technological base.

The second characteristic of the first space age was that the organization was very simple. There were the space agencies distributing money to industry under their control and for the benefit of dedicated and specific users.

The third characteristic of the first space age is that we were accustomed to budget regular growth.

This transition period opens the second age of space activities, and the second age of space activities will be characterized first, by the fact that expertise is now mostly with industry. The mature applications of space are driven by the market and are more and more integrated in the regular industrial, economic, and social world. They benefit each individual and are not only to specific users any more.

The second characteristic is that the actors are more and more numerous. There are many more actors than just space agencies and industry. And the organization becomes more and more complex. Industry has more and more different customers.

The third characteristic is that the public budget will stay, at best, constant in the foreseeable future. The two main consequences of this constant public budget are: first, the increase in the development of space activities will rely upon the development of private investments. Private investments require a feeling of stability. The horizon must be clear and clean and the rules of the game must be well defined. It's our duty to manage this transition period as quickly as possible in order to show a clear and clean reference picture to potential investors.

The second consequence is that to start new activities and face new challenges within the constant budget

of space agencies, it is necessary to transfer activities from these agencies to other organizations, especially the operational and routine activities. This transfer is already well advanced in Europe where Arianespace is operating the Ariane Launch Vehicle. EUMETSAT is operating the meteorology satellites. This transfer will be reinforced in the future.

The role of space agencies will be, therefore, in the future more and more focused towards science; science of the Universe and science of the Earth, science being also a factor of competitivity. Second, focused on access to space with the dramatic reduction of efforts dedicated to strategic aspects, but with an important effort dedicated to technologies able to reduce the launch cost. And third, and not the least, focused on exploration—and I think that Mr. Goldin gave a very interesting presentation of what could be the exploration in the 21st century.

There is not, therefore, one space policy, but a lot of different policies involved in space utilization: policy of science, policy of telecommunications, policy of environment, etc. The only common points among these policies are the means of access to space and some space technologies.

As for the applications, the role of space agencies can be limited to the promotion of emerging applications such as the utilization of microgravity. For the applications which are already identified for their social and economic benefits, the basic scheme should be a direct link between customers and suppliers. Governments are the worst partners for market-driven applications, especially because of the time necessary to make public budgets available. In addition, only investors can really make the cost decrease, not engineers.

Space agencies must, therefore, stay on the second row for these mature applications, their major role being to accelerate the transition toward the second age of space activities.

The last general aspect I would like to address is a trend towards an increased globalization of space activities. Any space nation cannot define now its future activities without analyzing and taking into account the international context. The international context has always been an important factor for space activities, be it for competition or for cooperation. But the recent political changes have opened new opportunities of cooperation and also have brought new competitors. This new international picture has generated instabilities, in particular in Europe, which is the only way to pass from one equilibrium to another equilibrium. In Europe, the balance between European autonomy and cooperation mostly with the United States, which was the basis of the 80s has to be revised now in order to be adjusted to the new world.

The most significant consequence of such a revision concerns the large infrastructure programs, namely the Ariane5 Launch Vehicle and the Space Station. As for Ariane, Europe has to face new competitors which reinforces the need to complete the development of Ariane5 as soon as possible. The first launch is scheduled now next November, meaning less than six months of delay compared to the initial plan defined 10 years ago.

As for the Space Station, and more generally, manned space flight, Europe has definitely abandoned the autonomous part of its initial plan. The Columbus Freeflying Laboratory, then Hermes, then finally the Crew Transport Vehicle have disappeared from our plans. Europe has kept its participation to the International Space Station. This was not so simple to get rid of the autonomous part of the main infrastructure and to refocus all European efforts toward the international collaboration part, even if this decision was the obvious move to do in view of the new international context.

The integration of Russia among the Space Station partners has made the International Space Station a unique enterprise. Unique because it is the first worldwide pacific enterprise. Unique because this is the right place to test new technologies, long-term maintenance, complex operations, long duration manned flights in view of future international exploration programs. Unique because of the resources the station offered to scientific users: tens of kilowatts, tens of cubic meters, tens of square meters, at least ten times what can offer a regular satellite, resources which are associated to regular visits, repairs, and reconfigurations.

Any space nation cannot define now its future activities without analyzing and taking into account the international context.

So Europe cannot be out of the international space station. Two weeks ago the member states of ESA reaffirmed their determination to participate, and they confirmed the basis of their participation: the provision of a laboratory attached to the Space Station and the provision of logistic services during the exploitation phase in order to offset their share of the Station's common operation costs.

As you can see, this participation is exactly what Europe has been committed to provide since its initial

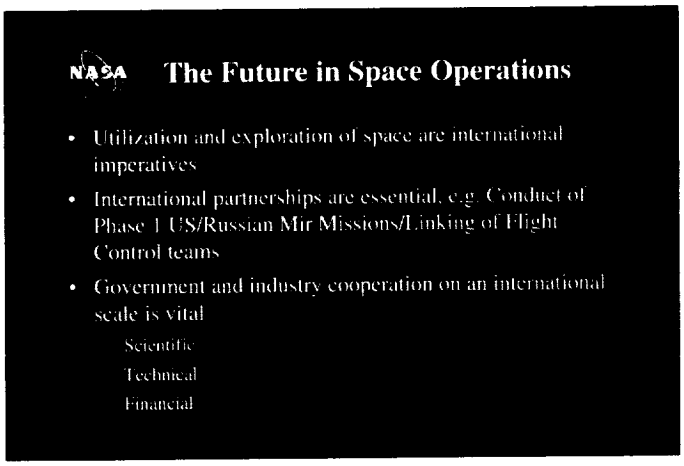

Figure WS-18

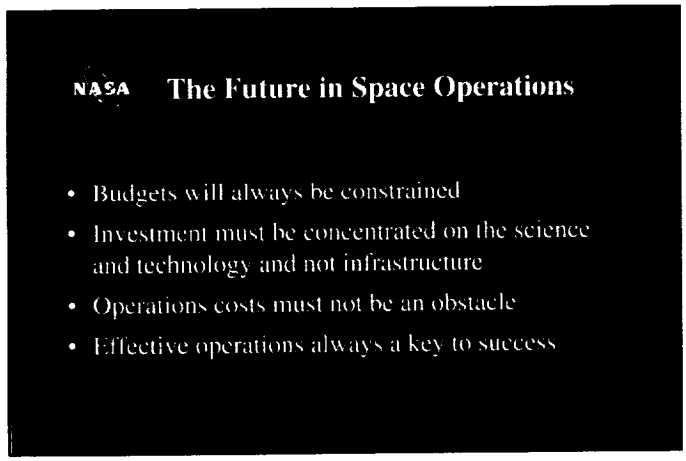

Figure WS-19

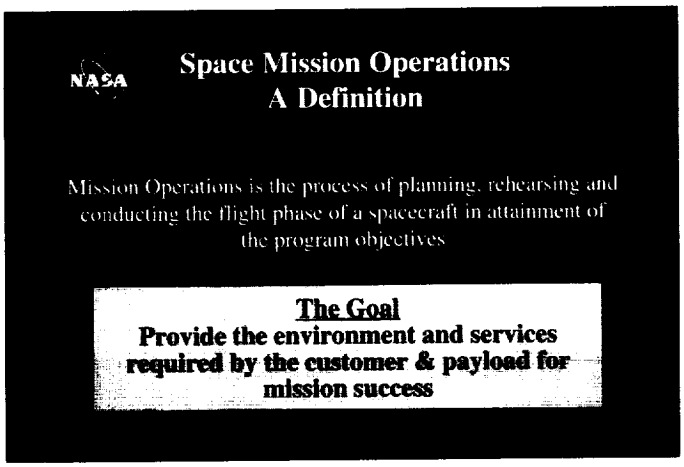

Figure WS-20

engagement. The only and important decision which still remains to be taken is a multiyear budget commitment which will be decided next October by the 14 ministers representing the member states of ESA. There are still some difficulties to overcome before such a multiyear budget can be committed, especially when this commitment must cover not only the development phase but also the exploitation phase, meaning almost a 20-year commitment. It's not so easy with 14 member states, and in the middle of a transition period. But the longstanding collaboration among the ESA member states has shown in the past that such difficulties can be overcome, especially in the frame of a broader package deal.

As a matter of fact, the budget decision on the European participation to the International Space Station is not the only one on the agenda of ministers next October. Three major programmatic decisions must be taken by ministers: the European participation to the station, the Ariane5 complementary programs including the evolution of the Ariane5 performance, and the scientific program for the next five years. These three major programs constitute a reasonable and balanced package where all member states can find their interest. The final decision will be a global decision on the overall package.

I shall conclude my presentation by recalling that the difficulties we are facing are just a result of our successes. In spite of these difficulties, space activities are not just discussions and paperwork. Major achievements will take place in '95 in ESA with six major missions, starting two weeks from now with the launch of the ERS-2 satellite. ERS-2 is a radar satellite which will be operated in tandem with its predecessor ERS-1 to bring stereoscopic radar pictures. After ERS-2, the next major mission will be the launch of an astronaut, Thomas Reiter, to the MIR station for a long duration flight of 135 days during which Thomas Reiter will perform extravehicular activities and participate to the maintenance of the MIR station. This mission is a concrete sign of the European will to participate to the station.

October-November will be a very busy period with the launch of three major scientific missions. The first one, ISO, is an infrared telescope launched by Ariane. The second one is SOHO, a solar observatory, launched by a U.S. Atlas vehicle. The last one is Cluster, consisting of four satellites dedicated to the study of the magnetosphere. The Cluster mission will be launched by the first Ariane5. The first flight of the Ariane5 is the first of the two qualification flights after which the operations will be transferred to Arianespace. As you can see, 1995 is a great vintage for ESA, full of missions and full of decisions.

Thank you very much.

DR. DAILEY: Thank you, Mr. Dordain, for the very important and useful insight into the European perspective. Another perspective comes from our next speaker, who has really been part of the past vision and most certainly was one of the people who brought reality to the past vision. We look forward to hearing his insights today with respect to how he sees the future. I'm speaking of John O'Neill, the director of the Johnson Space Center, Missions Operations Direc-

torate, which provides the pre-flight planning, training, and real-time flight control for NASA human space flight operations and for supporting transportation elements. He has had a management role in all major areas of JSC responsibilities from providing flight control teams and operation support to the disciplines of spacecraft systems, trajectory design, mission planning, and reconfiguration of flight software.

Mr. O'Neill's 30 years with NASA includes space systems operations and procedures, development for the Gemini program and management of the flight planning, and on-board data processes of Apollo and Skylab programs. Please join me in welcoming Mr. O'Neill.

MR.O'NEILL: Thank you. It's really a pleasure to be here today, and it's particularly an honor to share the podium with such a distinguished and visionary group.

Yes, I have been part of past programs in NASA, but we would like to think in the operations world that we must be an enabling part, a very enabling part, of the vision for the future which you heard articulated here today. The theme, yes, has been reality to vision. You could view what I will discuss as more toward the reality end. I would really ask you to share with me what are more along the lines of ideas as to how to enable the future. In particular, we need the participation of industry and new ways to work on that future.

New Partnerships in Space Operations (Summary)

The emerging era of international cooperation in space exploration and exploitation must face the constraints of limited resources. The initiation and development of projects that represent the future require that the operations expenditures of ongoing and new programs be reduced from present levels. Government and commercial partnerships in a new operations paradigm may provide lowered costs for programs and new opportunities for industry.

The Future in Space Operations - (Fig. WS-18)

The utilization and exploitation of near-Earth space will continue. The spacefaring nations of the world will press beyond low Earth orbit to explore our solar system and beyond. This will require partnerships on an international scale never before achieved in order to set the scientific goals, surmount the technical problems, and share the financial burden. The cost will be high on an absolute scale, but well worth the investment in the more relevant measure of the contribution to the future of our world.

A major challenge in the operations community is to fit the price of space endeavors into the agendas and the budgets of participating nations. Fortunately, the operations community is an international community that knows few boundaries and shares lessons learned, ideas, and plans as we work for the future. The operations function will continue to be critical—critical to the current engineering process of designing and developing better and more autonomous robotic and human spacecraft and critical to meeting mission objectives and dealing with the unforeseen.

Budget Challenges - (Fig. WS-19)

Programs must operate within tightly constrained budgets and provide for more return on resources invested. This clearly means that available resources must be concentrated on the objectives in space and the science and technology and not on Earthbound infrastructure. The budget must emphasize flight hardware and software. Operations and the overall approach to risk management must meet the requirements of safe and successful missions, but this must be achieved within a cost structure that does not impede new starts.

Two weeks ago the member states of ESA reaffirmed their determination to participate, and they confirmed the basis of their participation: the provision of a laboratory attached to the Space Station and the provision of logistic services during the exploitation phase in order to offset their share of the Station's common operation costs.

A Definition of Operations - (Fig. WS-20)

Because the concept to be discussed was developed from the perspective of flight operations, a definition is presented. Mission operations is the process of planning, rehearsing, and conducting the flight phase of a spacecraft to attain program objectives. This definition is also pertinent to this discussion because the scope of flight operations varies a great deal from one space organization to another, making comparisons difficult.

The Resource Allocations in JSC Mission Operations - (Fig. WS-21)

Using this definition for flight operations, the present resource allocation within the Mission Operations Directorate at the NASA Johnson Space Center is useful in making a point. The point is that approximately 70 percent of the resources go to the development of operations support facilities and systems and their maintenance and sustaining engineering.

Great strides have been made in reducing the cost of facilities through such logical steps as the use of commercial off-the-shelf hardware and software and

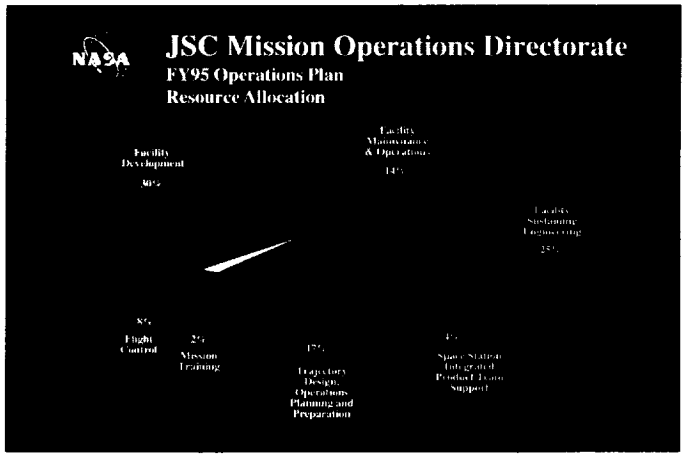

Figure WS-21

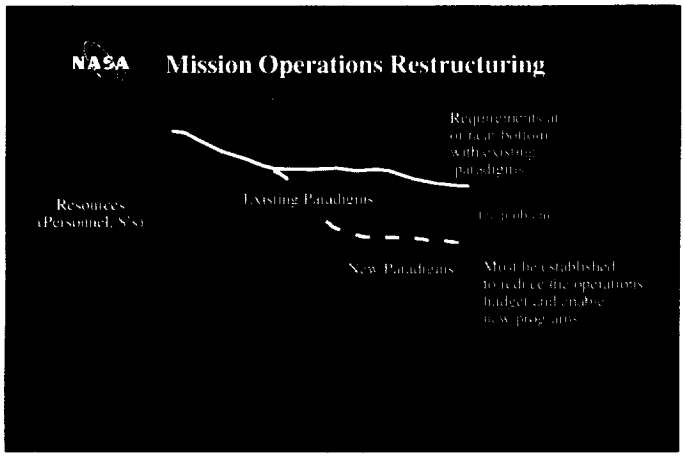

Figure WS-22

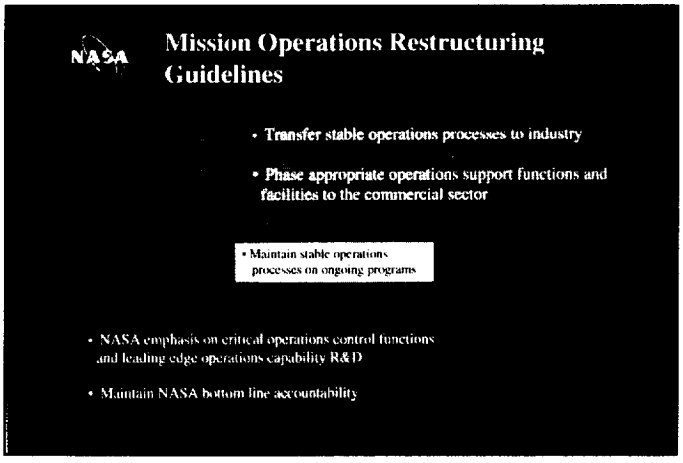

Figure WS-23

increased reliance on the maintenance services of the equipment suppliers. Despite these initiatives, the cost of ownership of the required facilities remains high. Further streamlining is also needed in actual flight preparation, training, and flight control processes.

Mission Operations Restructuring - (Fig. WS-22)

Flight operations cost reduction and process improvement initiatives have been and continue to be productive, but are beginning to show diminishing returns within the existing general framework of NASA and contractor relationships and ways of doing business. New paradigms must be examined and new partnerships explored in order to achieve the needed savings.

Restructuring Guidelines - (Fig. WS-23)

The principles guiding the studies of how flight operations might be restructured include the following:

- Maintain NASA's bottomline accountability.
- Maintain stable operations processes on ongoing programs.
- Transfer stable operations processes to industry at the earliest practical opportunity. Place the NASA emphasis on the critical operations control functions and leading edge research and development which contributes to more effective and autonomous operations.
- Phase commercially viable operations support facilities and functions to the private sector.

The New Model for Mission Operations - (Fig. WS-24)

In this proposed new model for mission operations, functions have been transferred to the contractor and to the commercial sector on two levels. In keeping with the bottom line accountability that will continue to be a government responsibility on NASA programs, the agency will set the program objectives and define the mission requirements that carry out those objectives. NASA responsibility would continue through the mission execution phase, where the mission director and flight director working with a small team would manage the real-time activities and support. The powerful automated capabilities and expert systems now available, and rapidly improving, plus increasing spacecraft autonomy should facilitate the flight control task and reduce the staffing required.

This model then modifies the way we work with the contractors during the flight preparation and training phase. The processes are changed from intermingled government and contractor tasks to objective contracting where the specific flight operations products and services necessary to execute the mission are clearly defined and have deadlines matched and measured against overall program schedules. This will reduce the government involvement and increase the accountability of the NASA contractors. It will also allow the contractors more freedom and incentives to streamline and reduce cost. A small NASA presence will be maintained in each major contractor discipline to interpret and coordinate requirements and schedules.

A more radical shift to industry responsibility is the third element of the model. It is proposed that commercialization of portions of the NASA operations

infrastructure offers the potential of significantly reducing the demands on the NASA budget while providing opportunity, not just cost reduction challenges, to industry. In this concept, commercially viable elements of NASA's command, control, and data services infrastructure would be packaged and offered for commercialization on a competitive basis. This proposal, which requires much additional evaluation, is based on the premise that NASA has developed many capabilities that could serve a wide range of other customers in the government, academia, industry, and international sectors. If these capabilities were commercialized, the operator could serve NASA programs on an anchor tenant basis but the operator would be free, and encouraged, to provide services commercially to other customers.

Recent facility developments such as the new Mission Control Center in Houston have provided extremely flexible capabilities which could serve a variety of customers with only modest augmentation. The services can be provided remotely at the customer's location. The end result could be significantly reduced NASA cost; business expansion potential for the commercial operator; and a cost-effective means of avoiding unnecessary command, control, and data services investment. The funding can be concentrated on the investment in space.

The processes are changed from intermingled government and contractor tasks to objective contracting where the specific flight operations products and services necessary to execute the mission are clearly defined and have deadlines matched and measured against overall program schedules.

To quote Mr. Goldin, our NASA administrator, in his statement at the White House on March 27 regarding reinvention and restructuring in the federal government:

> "NASA is an investment in America's future. The new NASA, as before, will inspire the next generation of explorers but cost the U.S. taxpayer less. At the conclusion of this process, NASA will be a more efficient, a more effective, and a more relevant agency."

We intend to play our part in accomplishing that. Thank you.

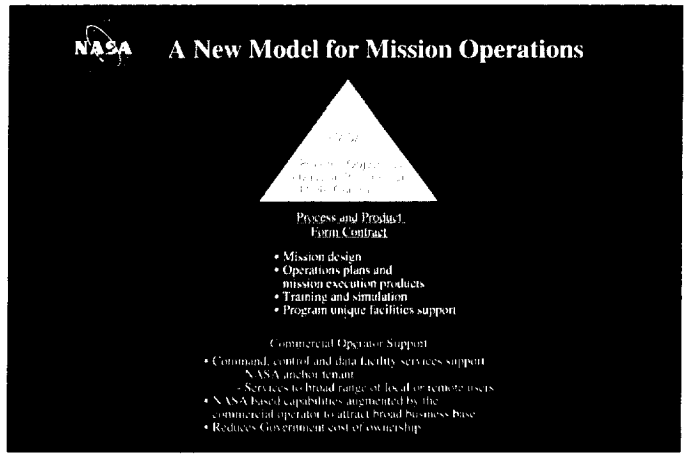

Figure WS-24

DEVELOPMENT OF CHINA SPACE TECHNOLOGY

1950s: CHINA BEGAN DEVELOPING ITS SPACE TECHNOLOGY (WHEN IT LACKED STRONG ECONOMIC POWER AND ADVANCED SCIENCE AND TECHNOLOGY)

AIMS:
- -- TO EXPLOIT THE SPACE
- -- PEACEFUL USE
- -- TO SERVE THE ECONOMY

MAJOR PROJECTS:
- -- LAUNCH VEHICLE
- -- APPLICATION SATELLITE
- -- SATELLITE APPLICATION TECHNOLOGY

Figure WS-25

ACHIEVEMENTS

WITH OVER 38 YEARS EFFORTS, CHINA DEVELOPED

- -- ABILITIES TO RESEARCH, DESIGN, MANUFACTURE AND TEST SATELLITES AND LAUNCH VEHICLES;
- -- LAUNCHING BASES SUCH AS JIUQUAN, TAIYUAN AND XICHANG, AND XI'AN SATELLITE CONTROL CENTER;
- -- LONG MARCH SERIES LAUNCH VEHICLES HAVING CARRIED OUT 36 MISSIONS SUCCESSFULLY;
- -- COMMUNICATIONS, METEOROLOGICAL, RECOVERABLE REMOTE SENSING AND SCIENTIFIC EXPERIMENTAL SATELLITES, WHICH HAVE BEEN PUT INTO OPERATION;

Figure WS-26

DR. DAILEY: Thanks, John, for that important overview. We all wish you the best because, obviously, if we can reduce operations we can put those resources towards better science and better exploration.

Our next speaker is from the People's Republic of China, Chen Baosheng, who is the chief executive officer of China Great Wall Industry Corporation in

ACHIEVEMENTS

(CONT'D)

- TECHNOLOGIES OF ROCKET STRAP-ON, HIGH ENERGY CRYOGENIC FUEL, MULTIPLE SATELLITES WITH A SINGLE LAUNCH, SATELLITE RECOVERY, REMOTE SENSING, TELEMETRY AND TELECONCTROL;
- A GREAT NUMBER OF EXPERIENCED AND SKILLED SPACE TALENTS

Figure WS-27

SERVING NATIONAL ECONOMY

OVER 80% OF THE ENTIRE POPULATION COULD RECEIVE SATELLITE TELEVISION;

MORE THAN 2 MILLION PEOPLE RECEIVED UNIVERSTIY AND TECHNICAL EDUCATION THROUGH TV TRANSMITTED COURSES, MANAGEMENT AND TECHNICAL TRAINING;

FORECASTING DISASTROUS WEATHER SUCH AS TYPHOONS AND RAINSTORMS THROUGH METEOROLOGICAL SATELLITES;

SURVEYING THE USE OF LAND, VEGETATION COVERING, ETC. BY SATELLITE REMOTE SENSING;

Figure WS-28

SERVING NATIONAL ECONOMY

(CONT'D)

EXPLORING SPACE ENVIRONMENT, CONDUCT MICROGRAVITY EXPERIMENTS IN THE FIELDS OF MATERIAL AND LIFE SCIENCES, FLUID DYNAMICS WITH THE USE OF RECOVERABLE SATELLITES;

HAVING ESTABLISHED INT'L SATELLITE COMMUNICATION BUSINESS WITH OVER 150 COUNTRIES;

SPIN-OFFS OF SPACE TECHNOLOGY.

Figure WS-29

the Washington, D.C. office. Mr. Chen has had extensive experience in Washington, D.C. serving from 1988 to 1992 as minister counselor for Science and Technology, Embassy of the People's Republic of China. He was responsible for overseeing Sino-U.S. cooperation in science and technology and as head of the science and technology section in the Embassy.

In recognition of his distinguished achievements in science and technology and contributions to international cooperation in science and technology and environment, he was appointed honorary fellow of the Washington Academy of Sciences. I want you to join in welcoming, and ask everybody else to do so.

MR. CHEN: Mr. Chairman, honorable guests, ladies and gentlemen, dear friends. Six years ago, I had the honor of participating in the 5th National Space Symposium. Instructed by Mr. Liu Jiyuan, administrator of China National Space Administration (CNSA), I am now very pleased and honored to attend the 11th National Space Symposium here today.

In my speech today, I will briefly introduce the development of China's space technology and its international cooperation, in particular the cooperation between China and the United States of America. Slides please (*Fig. WS*-25).

China began the development of its space technology in the 1950s. Although China has no strong economic power and advanced science and technology, China has raised money to develop launch vehicles, application technologies, satellites and satellite application, following the principle of "developing space, for peaceful use and serving the economy." Next slide please (*Fig. WS*- 26).

China now has highly skilled professional technicians and workers. China owns the Jiuquan, Taiyuan, and Xichang satellite launching bases and Than satellite control center, which are capable of launching low Earth orbit satellite, sun-synchronous orbit satellites, and geostationary orbit satellites. China has also developed a high-energy, cryogenic fuel technology for launch vehicles, rocket strap-on technology, and technology for lauching multiple satellites with one rocket. Long March Series Launch Vehicles have launched 36 commercial missions successfully. China is also improving its satellite recovery technology and remote sensing, telemetry, and telecontrol technologies. Next slide please (*Fig. WS*- 27).

The development and application of China's space technology has played a special and indispensable role in China's modernization construction. Next slide please (*Fig. WS*- 28). The Chinese government attaches great importance to the development of space resources and space technology and has included space technology as a part of its overall national development strategy. The National Mid- and Long-term Program for Scientific and Technological Development for 2000 to 2020 focuses on strengthening the development and research of space power systems, propulsion, TT&C, and manned space technologies. Next slide please (*Fig. WS*- 29).

We are preparing "The Sustainable Development Action Plan for the Promotion of China Space Application." By the end of this century, China will develop large-capacity communications and broadcasting satel-

KEY POINTS OF CHINA'S
SPACE TECHNOLOGY DEVELOPMENT PROGRAM

CHINESE GOVERNMENT ATTACHES GREAT IMPORTANCE TO DEVELOPING SPACE RESOURCES AND SPACE CAUSE;

THE CHINESE SCIENTIFIC AND TECHNICAL CIRCLES AND OTHER GOVERNMENT DEPARTMENT FULLY SUPPORT SPACE TECHNOLOGIES DEVELOPMENT;

"THE NATIONAL MID- AND LONG- TERM PROGRAM FOR SCIENCE AND TECHNOLOGY DEVELOPMENT FOR YEARS 2000-2020" SAYS:

"(WE SHALL) KEEP STRENGTHENING THE DEVELOPMENT AND RESEARCH OF SPACE POWER SYSTEM, PROPULSION, TT&C AND MANNED SPACE TECHNOLOGIES";

Figure WS-30

KEY POINTS OF CHINA'S SPACE TECHNOLOGY
DEVELOPMENT PROGRAM

(CONT'D)

BEFORE THE END THIS CENTURY, CHINA IS COMMITTED TO:

- DEVELOPING LARGE-CAPACITY COMMUNICATION & BROADCASTING, EARTH RESOURCE, AND GEOSYNCHRONOUS METEOROLOGICAL SATELLITES
- MAKING USE OF SATELLITE APPLICATION NETWORK BY ALL WALKS OF LIFE AND MODERNIZING INFORMATION TRANSMISSION
- CONTINUING TO PROVIDE LAUNCH SERVICE TO INT'L CUSTOMERS

Figure WS-31

lites, multi-function Earth resources satellites, and geosynchronous meteorological satellites, as well as improving ground application systems and lauch services to international customers. Next slide please (*Fig. WS-* 30).

After these application satellites are launched and put into operation successively, China will set up an autonomous, steady operational and space-Earth integrated satellite application network which will be linked with international networks. This will result in China's realization of modern information transmission employing satellite application networks in agriculture, forestry, fishery, animal husbandry, industry, communications, commerce, finance and tax, as well as the security and futures markets. China will also continue to conduct research and development of manned spaceflight technology.

While meeting the domestic demand first, China will also use its Long March vehicles and various satellites to provide satellite launching services to meet the ever-growing demand of the international satellite market. Next slide please (*Fig. WS-* 31).

At present, all the countries in the world—both developed and developing countries—are facing common difficulties, including population and resources, environment and disaster, communications and transportation, education, and culture.

The accumulation of space activities and the development of technologies, especially the ever-growing maturity of manned space technology, show that the future development and application of space resources have a broad and bright prospect. The exploration of space resources is a great undertaking which can bring benefit to all humankind but cannot be completed by an individual country or a nation and cannot be realized within several years, even a century. It requires difficult struggle of all humankind from generation to generation and the great efforts taken by every country in the world. For these reasons, China has always actively advocated international cooperation in developing space technology, and has put forward the following four principles for international space cooperation (*Fig. WS-* 32):

So far the China National Space Administration (CNSA) has carried on technical exchanges and contacts with more than 70 countries and regions in the world and established extensive relations with international space organizations and space academic institutes.

1. To make international space cooperation on the basis of equality, reciprocity, learning from each other's strong points and making up our deficiencies;
2. To peacefully use space resources and develop satellite and satellite application technology to serve development of economy and social progress of humankind;
3. To follow the principle of free, equal and fair competition, provide satellite launch services and carry out trade activities of satellites and space technology products;
4. The developed countries should help developing countries to develop space technology and use space technology to develop economy.

So far the China National Space Administration (CNSA) has carried on technical exchanges and contacts with more than 70 countries and regions in the world and established extensive relations with international space organizations and space academic institutes. CNSA has signed cooperative agreements with counterparts of Germany, France, UK, Italy, Sweden, Brazil, India, Korea, USA, Australia, Russia, and other countries.

Now let me address the bilateral cooperation between China and the United States. After the normal-

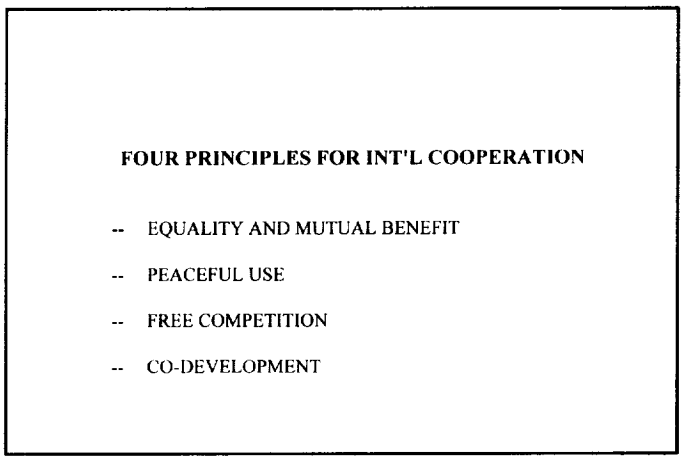

Figure WS-32

	Satellite	Manufacturer	Spacecraft	Launch Vehicle	Launch Date
1.	AsiaSat-1	Hughes	HS-376	LM-3	April 7, 1990
2.	Optus B1	Hughes	HS-601	LM-2E	August 14, 1992
3.	AP Star-1	Hughes	HS-376	LM-3	July 21, 1994
4.	Opus B3	Hughes	HS-601	LM-2E	August 28, 1994
5.	AsiaSat-2	Martin Marietta	MM-7000	LM-2E / EPKM	August 1995
6.	Echostar-1	Martin Marietta	MM-7000	LM-2E / EPKM	October 1995
7.	Intelsat 708	SS/Loral	FS-1300	LM-3B	December 1995
8.	Intelsat 801	Martin Marietta	MM-7000	LM-3B	Febuary 1996
9.	Echostar-2	Martin Marietta	MM-7000	LM-2E / EPKM	August 1996
10.	Intelsat 805	Martin Marietta	MM-7000	LM-3B	May 1997
11.	Iridium	Motorola		LM-2C	June 1996-2002

Figure WS-33

ization of the relations between China and the United States, both government space organizations expressed positive wishes toward Sino-U.S. space cooperation. About 10 years ago, leaders, specialists, and astronauts from NASA visited our space organizations; and likewise, our leaders in the space department, including state councilor Dr. Song Jian, have paid visits to NASA headquarters and its space facilities and laboratories. Through these friendly contacts, mutual understanding and friendship have been enhanced. As a result, mutual interest in several cooperative projects has been expressed. In 1984, both parties prepared to sign a protocol on space cooperation. Mr. Richard Johnson, the former assistant director in the White House Office of Science and Technology Policy, proposed that Chinese scientific experimental equipment and Chinese astronauts could be deployed aboard the U.S. space shuttle. For various reasons, however, contacts between our two sides have been suspended for several years, and cooperation documents have not come to any conclusion. Nonetheless since 1988, the China Great Wall Industry Corporation (CGWIC), a subordinate to China National Space Administration, and Hughes have cooperated in commercial launching service. Three agreements between the two governments were signed at the end of 1988 and beginning of 1989.

On behalf of the Chinese and the U.S. governments, Administrator Liu Jiyuan and Ambassador Kantor signed a new seven-year Commercial Space Launch Agreement in Beijing on March 13, 1995. To date, six satellites for international customers have been successfully launched by the Chinese Long March vehicles. CGWIC has also contracted with several American companies to launch 30 more satellites. This partnership is paving the way for future cooperation on satellites and satellite ground application systems.

In 1988 and 1994, I had the honor to participate in all the consultations between our two governments. In my opinion, it is a very good and typical cooperation to launch satellite manufactured in the U.S. on Chinese vehicles for the third party or third country. Through our cooperative programs we have not only developed a good relationship with Hughes Space Aircraft Company, but also with Space Systems/Loral, Lockheed Martin, and other companies. This next slide shows the planned launches (*Fig. WS-* 33).

We have found launch services can be also beneficial for other industry cooperations between China and the U.S. Taking Iridium as a good example, we invest 75 million American dollars to be a member of board directors of Iridium Inc. We import ground equipment. Eventually cellular telephone systems of Motorola will win the Chinese telecommunication market.

Launching service is only a part of space cooperation. We are greatly encouraged when we look at the overall cooperation in the space sector between our two countries. In January 1995, a joint Sino-U.S. Science and Technology Commission meeting was held in Beijing. One of the meeting highlights was space cooperation. Both sides agreed that potential areas of space cooperation might include Earth science and global change research, telemedicine, and space sciences.

The exchange was warmly received by Mr. Goldin of NASA and his colleagues. The meaningful and eloquent speech Mr. Goldin delivered during the Joint Commission Meeting has left a very good and deep impression on the Chinese participants. Later this year senior people from China National Space Administration might be here in Washington D.C. It is my hope those mutual visits will open a new chapter in the space cooperation between China and U.S.

I do believe that as time passes, mutual understanding will deepen, and our cooperation in space technology will be further developed and more extensive with promising and effective prospects.

Finally, please allow me to conclude my speech with some words from the speech Mr. Goldin delivered in Beijing: "Collaboration in space can be a catalytic action for making this world a safer and more

peaceful place. When nations work together on bold and noble tasks to benefit humankind, we build understanding, respect, and trust." Thank you.

DR. DAILEY: Thank you very much for a most enlightening speech. Our next speaker is someone who it gives me great pleasure to introduce, someone I got to know when I was serving in government myself. He, of course, is Dr. Roland Doré, who, since October 1994, has been serving as the president of International Space University in Strausberg, France. ISU is an international and multidisciplinary institution preparing professionals to respond to the current needs and evolving demands of the space sector in a rapidly changing world, truly the ones that are going to be providing our visions and reality in the future.

Prior to that, though, he held the distinguished position as the president of the Canadian Space Agency in May 1992 until July 1994. From 1960 to 1992, Dr. Doré has occupied various professional and administrative positions in Canada. In 1980 he was appointed dean of Research of the Col Holitique and dean and director in 1982. He went on to become the Col's principal and chairman of the board in 1989 until 1992 when he was appointed the head of the Canadian Space Agency.

Dr. Doré has authored or co-authored more than 70 scientific papers published in reference journals, and he has lectured extensively at international conferences devoting his career to engineering, education, and research. We welcome Dr. Doré.

DR. DORÉ: Thank you Mr. Chairman; my friend, Mr. Goldin; ladies and gentlemen. Of course I want to talk to you about the International Space University. But since we're in the business of training and preparing young professionals for the space world of tomorrow and since this space world is changing, I would like to give you my views about why it is changing, how it will change, and how this will affect the education programs around the world to prepare these people.

Of course, these are not new ideas, but it might come from a different perspective, a perspective of somebody who is part of a neutral organization that has to do with education.

The world is changing now, and it will be changing in the future. But there are two main factors, I think, that are lasting factors that will trigger that progress in the future, the change that will come in the future years.

First is the realignment of the world political structure. It's now tentative. Of course there was a major event that happened in 1989 and the early 1990s, but the situation in Russia, if you look at it, is still very unstable, and we hope that our friends from Russia will go through that difficult period with a happy ending. This has triggered, of course, (it was mentioned this morning when we had the very good session when the military people in this country presented their views on the future of space) a lot of instability all over the world.

And the second major, and I think lasting also, reason why the world is changing and how it affects space is the world economic crisis. This crisis will not last for long. So I hope it will be short, but it will be longer than the past crisis.

I do believe that as time passes, mutual understanding will deepen, and our cooperation in space technology will be further developed and more extensive with promising and effective prospects.

So are the consequences of these two major factors on the space sector. And if you look at the second one, the question of economics is that the space sector is bound now to generate benefit at the social level and the economic level. It means that now space will be pulled—the development of space infrastructure and space activity will be pulled—by needs and not only pushed by the technology. You know, the engineers (I'm an engineer; I know the way we are.) we have a new technology, we say we're going to push that, this is finished. It won't be like that in the world. The needs could be a scientific need; we've talked about that. It could be a need to explore the universe; this is a need. But it won't be pushed by technology; it will be pulled—these developments—by the fact we have a need to accomplish. The technologies are, of course, available most of the time. And especially when we look at the domain of applications that are more directly related with social needs; that is, telecommunication and Earth observation. In those two domains especially, the driver will be how much economic benefit can we pull out of these activities.

And the second consequence of this reorganization of the world scene is the fact that the international cooperation in many sectors (but particularly in space because these programs are very costly and they involve many countries), the international nature of the space activity, will certainly follow directly. Of course, this is not new, cooperation at the international level, but I think the level will increase tremendously.

There are other consequences of these major changes in the world—the reduction of space budget coming from governments. People are talking about a level budget. I don't think so. For civilian programs I think the budget will go down because the private sector will take over the sector of application and telecommunication until it's done; in fact, it is done. The governments are investing only in technologies of the future. They don't invest anymore in developing

the satellites. The companies are doing that. This will come also in the Earth observation business. It might take longer because the economic benefit of the Earth observation might not be as evident as those in telecommunications, but it will come. So it doesn't mean that the total spending in space will go down, but certainly the spending coming from government will go down and will be focused more in science and the development of technology of the future, science being understood as science material, exploration, manned space activities and so on.

. . .this new reality of internationalism forces us to consider another form of training. We have to give a broad education to those young professionals who will have the responsibility to develop the infrastructure and the space applications for the needs of future generations.

There will be a new equilibrium in players. There used to be two major players in space, but now it's spreading. Look at what India has accomplished in the past 15 years. It's tremendous what they've accomplished in the past 15 years. But we will see also the increased importance of the countries that are not providers of a space infrastructure but that are users of space infrastructure, especially in telecommunication and Earth observation. These countries will be players that are of importance because part of the economic benefit—the greatest part of the economic benefit—is coming not from what we put in space. What we put in space is spending. It's what we do with that on Earth in terms of especially telecommunication and Earth observation.

We will see, of course, the convergence of civilian and military programs. This morning there was a good session; there was a good turnout of civilian and military people, and this intention was clearly stated. It's not so obvious this afternoon, but that's it.

Major changes of attitude in space cooperation, space agencies. Mr. Dordain just mentioned that we have to change our attitude in space agencies. NASA is doing that now, but it will also be done in cooperation. If we look at the production of space products that are flowing out of our borders, the borders being Europe, being Japan, being United States . . . I mean, it's minimal. It's minimal because companies are being fed by government programs. But now we're entering an era where we will see probably the downfall of these barriers, and companies will be entering the path of competition. That means, if you have to train for a marathon, of course, you don't do it by driving a car. This is what we've been doing in the past, because companies, it was easy, I know, because I've seen it in Canada. Companies were being fed by government programs but now they have to be competitive, and so they will have to step out of their cars and start training for a marathon which is difficult. It's a difficult task. So, I'm sorry. I'm sorry, being crude sometimes, but this is my view.

So what about space and education? Of course, we're talking about international, economic benefits. We need different types of people. We used to train, we still train, and we still mean to train specialists and engineers who can develop space infrastructure. We need scientists, we need managers, we need lawyers to tell us if we can put a satellite disk at that place or that place. But we need also those people who not only come with their technology baggage of knowledge, but also the openness of mind to understand that when we're proposing a new space program, money has to be involved, management has to be involved, law has to be involved. And, of course, this is a new type of person.

This is the vision that our founders, three young graduates from MIT, had in the early '80s. These three young men saw that the space world would change in the way it is changing now. And they said, "We need to train people with a broader view on space activities."

Space and Education—Contribution of the International Space University (ISU)

Space activities are now becoming more and more international. It is obvious that we need to consider the training of our space professional in this new context. And in fact, in many of our countries, we do have programs by which we train specialists, in space medicine, in engineering, in science. In some cases it is also in management of space activities or in space policies. But, this new reality of internationalism forces us to consider another form of training. We have to give a broad education to those young professionals who will have the responsibility to develop the infrastructure and the space applications for the needs of future generations.

How does the International Space University (ISU) contribute to fulfill such a need?

Since its creation in 1987, the ISU has been a truly multidisciplinary and international institution preparing individuals to respond to the current needs, and the increasing and evolving demands, of the space sector in a rapidly changing world. ISU's greatest strength is its diversity and heterogeneity—both intrinsic components of space activities today. ISU considers space activities not as isolated actions undertaken by a narrow community, but as a global undertaking of human-

ity in which diverse systems and new technologies flourish. This calls for a non-traditional approach to the education of space professionals.

ISU offers a multidisciplinary curriculum stressing interactions between disciplines within an international setting. It considers this approach to be an essential complement to traditional training structured around one or two disciplines. Integrating the output of skilled specialists requires professionals who can see a broader picture. Without sufficient understanding of the full range of space disciplines, complex space programs can not be effectively managed. ISU students study the broad spectrum of space-related disciplines which gives them the opportunity to expand their perspectives and to understand the complex interactions among disciplines.

Studying with professional colleagues from around the world leads students into a worldwide network and into a new way of working. Participants join the rapidly growing ISU community which provides unparalleled resources of information and expertise spread through governmental, industrial, and research institutions around the world. The ISU educational process helps participants to overcome the cultural barriers which often impede progress on international space programs. The ISU educational programs are structured so that participants learn to work effectively with professional colleagues from diverse cultural backgrounds with different problem-solving approaches.

ISU currently offers two educational programs: the Summer Sessions (SSP) and the Master of Space Studies (MSS). Both programs offer opportunities for individuals to acquire a wide-ranging knowledge of space-related disciplines together with a greatly enhanced understanding of how space activities really work. The engineering disciplines, the pure and applied sciences, law, management, policy studies, and humanities are among the disciplines studied. Both the space segments and the ground segments of space projects are dealt with, as well as their utilization and their impact on society.

The ISU Summer Session is an intensive 10-week program which provides an overview of space activities all over the world. The annual program, offered each year since 1988, is held at different universities and research centers around the world. The ISU Summer Session offers a unique educational experience, highly valued by the more than 850 alumni from 56 countries who have already participated. The multidisciplinary curriculum, with its emphasis on international cooperation, opens the student to new perspectives on the world's space activities, perspectives otherwise reserved for those with many years of varied professional experience. All the major space-related disciplines are studied. This, in combination with the team work of the Design Projects, broadens the participants' knowledge beyond that of their original specialization and gives them a greatly improved awareness of the total system. Some 450 space specialists from 25 countries have contributed as lecturers, faculty members and invited speakers during the past seven Summer Sessions.

The MSS is a graduate-level program designed for individuals seeking professional development or further academic study by working towards a one-year degree. This new and unique program will be launched in September 1995 in Strasbourg, France for a class of 30 to 40 students.

For experienced professionals, the MSS program is organized to support career advancement, a career shift within the space sector, or a career move into the space sector.

For students who wish to follow a more academically oriented career, the MSS can lead to research opportunities including a Ph.D. program. In the same context, the MSS could be integrated into a Ph.D. program that the student is already pursuing. The MSS program could also constitute a complementary educational component after a Ph.D. program, preparing individuals for professional life in industry or government agencies.

The multidisciplinary curriculum, with its emphasis on international cooperation, opens the student to new perspectives on the world's space activities, perspectives otherwise reserved for those with many years of varied professional experience.

Space development will remain an important sector of activity for the foreseeable future. Space programs have brought major direct, practical benefits to humankind through telecommunications, remote sensing, and other applications. Space programs are essential for the conduct of many areas of pure and applied scientific research, from astronomy to bio-medical research. Space programs can also capture the human imagination and provide an unequaled outlet for the human spirit of adventure, especially by enabling men and women to venture into space.

The MSS program has been shaped by the need to sustain a suitably educated body of professionals capable of adequately managing this important worldwide activity. The creation of a space program, the implementation of the space segment and the ground segment, the exploitation of the results of the program, and its interpretation to society at large is a very complex process. A very wide range of scientific, engineering and management factors must be combined, taking into account the economic, legal, political, and cultural environment in which the space program takes place. The successful integration of these disparate

elements into a workable system requires a body of highly capable professionals.

Skilled specialists are, of course, essential to this process. Equally important are people who have an adequate breadth of knowledge of all the relevant disciplines, both technical and non-technical, and who are able to see the system as a whole. Since space programs very often involve cooperation between nations or cooperation between private companies in different nations, one special quality that is of great importance is the ability to work effectively and efficiently with professional colleagues from different cultures having widely different working methods. It is this breadth of knowledge, combined with the ability to manage the interactions between disciplines and the ability to operate on an international plane that the MSS program will impart to its students.

International, multicultural and interdisciplinary—these are the three principles of ISU's activities. In this way ISU hopes to create, for the 21st century and beyond, a new synergy among the people of the world.

The MSS program provides an opportunity for professional development and academic advancement. In particular, the participants will:

- gain a comprehensive base of knowledge in all major space-related disciplines (technical and non-technical) and their interrelationships.
- become part of an active worldwide network of professional colleagues.
- take part in a design project, which will provide an opportunity
  - to learn through experience how to work with colleagues from around the world,
  - to put into practice the theoretical instruction, and
  - to confront the challenge of creating a realistic design of an international space program.
- pursue an area of specialization through advanced lectures and seminars in selected topics.
- undertake an individual project linked with an eight-week placement period for practical training in a foreign space agency or company or for specialized courses and research at an ISU Affiliate.
- develop the professional skills and personal qualities required to design, implement, lead, and manage space programs.

The main tools to achieve the stated objectives are a balanced series of lectures on all major disciplines related to space; design projects of a nature involving most, if not all, of those disciplines; and a series of lectures on contemporary issues and events which as a whole provide a multidisciplinary education.

ISU is committed to the concept of a close student-teacher relationship in which continued personal interaction constitutes a substantial part of the educational process. The formal supervision of each individual student will be ensured by a guiding committee which will include a guiding professor from the central campus and an academic mentor from an affiliate, and may include other people involved in the student's training. The guiding committee will be responsible for the academic well being of the student and will provide advice and guidance to the student on academic issues such as selecting advanced courses and a design project, and choosing an affiliate or host institution for the placement period.

The Summer Sessions and Master of Space Studies programs are supported by a unique campus consisting of a central campus and a number of affiliates (24 affiliates at the present time), linked together through electronic communication and information systems.

The central campus of ISU is located in Strasbourg, France and provides the main facilities for the MSS program.

The ISU affiliates are located at institutions around the world. The affiliates are integral partners in ISU and exchange faculty members, conduct joint research, provide students to the MSS program, host students during their placement period, supervise them during the MSS program, cooperate in the MSS curriculum definition, and work with the central campus on other mutual academic endeavors. After the MSS program, the affiliates may select some qualified MSS graduates to undertake further study or research.

ISUnet connects the many elements and constituencies of ISU—the faculty, students, and alumni—through Internet. ISUnet will utilize the most appropriate communication and information technologies to provide a simple and cost effective electronic network among the ISU campus elements, additional institutions and corporations along with suitable electronic databases.

Closely integrated with ISUnet is the ISU Information Resources Center which provides library and other information resources to ISU faculty, students, and the affiliates. ISU will be electronically linked to libraries around the world. Students will also have open access to the libraries of the Strasbourg universities.

ISU intends to maintain a balance between teaching and research. Considering the wide-ranging disciplines of ISU programs, some faculty members will be actively engaged in development programs and other creative activities in addition to traditional research activities. ISU, with its international and multidisciplinary character, intends to become a catalyst for the conception of new research and development programs and other creative activities.

In all of these activities, ISU professors—supported by students, research/teaching assistants, and MSS graduates—will take the leading role. Collaboration with research groups in the affiliates and other institutions will be strongly encouraged. To favor the best environment for research by the academic personnel of ISU, institutional support will be provided for the development of research facilities as the central campus grows and consolidates.

International, multicultural and interdisciplinary—these are the three principles of ISU's activities. In this way ISU hopes to create, for the 21st century and beyond, a new synergy among the people of the world.

Thank you.

DR. DAILEY: Thank you, Roland. Now, our last speaker is Mr. Lon Rains, who is the editor of *Space News*. Lon has been editor of *Space News* since 1993. He is responsible for all of the newspaper's news and editorial coverage. Lon joined *Space News* in October 1989 as the Advanced Technology and Soviet Space Program reporter. He was responsible for covering the former Soviet Union's military and civilian space programs and a number of civilian and military space programs in the United States.

In January 1991 he was promoted to senior editor and supervised the editing staff, freelance writers, and the production of the newspaper. As a deputy to the editor of *Space News*, he also wrote editorials and was responsible for all facets of the newspaper's publication in the editor's absence.

He has worked as a journalist since 1982. He came to *Space News* from *Prince George's Journal*, a daily newspaper in the Washington, D.C. suburbs. His assignments at the *Journal* were federal government, including coverage of the Goddard Space Flight Center; the Maryland Congressional Delegation; and the Maryland Legislator and Governor. He also has covered federal and state courts. He holds a bachelor's degree in political science from The University of Maryland, and I also join in welcoming Lon to the podium.

MR. RAINS: Thank you, Brian. I've been asked to sum up the last couple of days of discussion of vision and reality, and as the last speaker I feel it's my moral obligation to be brief, so I'll try to do that. Before I start, I want to thank Dick MacLeod and a great staff of volunteers for the great job they've done this week.

How close the vision is to reality in a space program depends on which program you're talking about, and clearly, commercial, military and civil space programs are at very different evolutionary stages right now, as are space programs in different countries.

I want to start off with the military space programs, because I believe those are where the gap between vision and reality is currently at its widest. Space systems and aerospace technology took center stage on the battlefield during the Gulf War, and in the months that followed, there was a lot of talk about what an impetus their success in the war would be to the development and expansion of U.S. military space capabilities. It didn't happen, at least not the way a lot of people thought it might. The U.S. budget deficit is too large, and space programs are as vulnerable as any other system as the defense budget continues to shrink. Ironically, for the United States at least, is the Europeans, who took the lessons of the Gulf War to heart and they're moving quickly to develop an independent military capability in space.

The good news is that budget pressure is forcing the Pentagon to change its ways, and while such change is very slow, there are positive trends such as the move to make much better use of the technology available on the commercial market. But all in all, military and intelligence spacecraft are too large, too expensive, and too inefficiently managed.

The U.S. budget deficit is too large, and space programs are as vulnerable as any other system as the defense budget continues to shrink.

The good news is that there are pockets of resistance within the Pentagon, in secret little corners of the military. There are some bright and innovative spacecraft managers who know what needs to be done. The biggest favor the top brass and a lot of managers in the middle could do is get out of their way and let them show what they can do. I think that's important, because the need for space systems has not diminished; it's increased.

The threats are different than those the U.S. faced in the Cold War; but particularly when you talk about the growing ballistic missile threat, it's growing even as the budget shrinks. In that environment, moving away from the current over-reliance on large, multi-billion dollar satellites is essential. I think the National Reconnaissance Office, in particular, needs to reinvent the way it manages spacecraft development and also start thinking about developing a small spacecraft capability. Every mission does not require the most up-to-date and technically sophisticated spacecraft possible.

Whether they should or not, defense budgets are not going to grow and are likely to continue to shrink. Even if the funding is stabilized, space systems will have to compete with a long list of equally pressing needs. The only way to get more capability in space is to get a lot smarter about the way we spend these scarce resources.

NASA, I think, is slightly further along in the attempt to streamline and modernize. But make no mistake, the movement that Dan Goldin started three years ago to remake NASA is only beginning. Despite all the talk about pain and cuts, NASA's budget has not been cut significantly to date. It is still $14 billion, and that's a lot of money. If the five-year budget outlook for NASA recommended by the White House this year becomes reality, the change ahead will have to be far more revolutionary than the changes to date.

But give NASA credit. Dan Goldin does have a vision of what NASA should be, and he's doing more than any agency head in the U.S. Federal government to streamline, downsize, and innovate. If every government manager was a tenth as aggressive as Dan Goldin has been, the country would be in far better shape.

Commercial space activities today are far and away some of the most exciting things happening in the industry. It is where the vision clearly is closest to reality.

That's why I think the White House made a big mistake this year when it asked NASA to reduce that five-year budget plan by as much as $8 billion. On one level, it's reasonable to ask any government agency to scale back when industry has been doing it for years. But it seems to me that when an agency has been more aggressive about changing itself than any other part of the federal bureaucracy, it sends the wrong message to reward the innovator by asking him to cut even deeper once he has proved that he can do it. The message there to other agency heads is to drag your feet and fight for your budget because if you innovate, you will only be cut faster and deeper.

There are legitimate reasons for keeping NASA's budget at least at current levels. As too many speakers have noted this week and for too many years to count, the high cost of space launch continues to inhibit the growth of the space business. While the X-33 and X-34 efforts are an encouraging sign that the United States may, *may*, tackle this problem in a significant way, it is not the priority that it should be or could be. It's a shame because new launch technology could add even more impetus to an already thriving commercial space business.

Commercial space activities today are far and away some of the most exciting things happening in the industry. It is where the vision clearly is closest to reality. The satellite communications industry, for years the only profit-making space enterprise, is poised for dramatic expansion of new businesses like satellite-based mobile telephone and data service and direct broadcast television. The remote sensing industry and the commercial use of GPS technology are creating vibrant new markets. The amazing thing about the commercial market is that things are booming even, as Steve Dorfman noted yesterday, as launch costs become an ever larger part of doing business. Imagine the industry's potential if launch can become more affordable and more reliant.

I continue to believe the visionaries like Tom Rogers also have it right when they say the only way to ever get the public's full support for space programs is to begin shaping programs in a way that includes the average person in a very personal way.

For those of you who were here on the opening night, I want to say to Jim Lovell that a lot of those hippies he talked about were supporting the space program then, and as those people enter middle age now, they still share with many people in this room the vision of a space program that will allow them to leave low Earth orbit or to reach low Earth orbit in their lifetime. The longer they're shut out of participating in that vision, the harder it will be to find the money to make it a reality. Thank you.

Q&A

DR. DAILEY: Thank you, Lon, for being succinct and it has helped, I think, give us some more time for questions and answers. If I might ask all the participants to turn on their microphones, we'll be able to direct some questions and, I think, get some interesting dialogue here.

First question goes to Mr. Goldin. Speakers in this morning's session and Representative Walker spoke of how the U.S. "must dominate" space. How is "domination" international cooperation?

MR. GOLDIN: Space, like any other area, requires that each country do things in the national interest. Space is not going to be WASA, the World Aeronautics and Space Administration. Space is going to be done on a government basis when it's in the national interest of each government to do it. And if it is in the national interest of each government to participate in specific programs, they will do it. In the commercial sector, the same thing happens. Global alliances get formed, a corporation is in the lead, it is in their interest to work with other corporations because it generates new markets. So there's no contradiction.

America does what it believes is right, and Congressman Walker indicated that there are areas where America wants to develop technologies and leadership in the new world. Leadership in the new world will come by doing things at a much higher level of technology with system management skills so that the country can grow and prosper and in that way, interact with other nations.

So I don't think there's any contradiction. I think it's the right thing to do. Where countries can do things of mutual interest, and there isn't a competitive aspect, we ought to do it.

DR. DAILEY: Thank you. The next question goes to Mr. Johns. If the international information superhighway becomes a reality but uses fiberoptics, will the communication and space industries suffer major market share losses?

MR. JOHNS: In fact, in my view, the satellite industries are going to be a very important part of the GII, the Global Information Infrastructure. Much of our commercial application has been broadcast cable and so on, which is a one-way sport. Increasingly, we are going to be talking about real-time video band widths and an interactive transfer of information between people, between governments, between corporations. And it's going to be a ubiquitous system. In similar high capacity two-way systems, they are going to be an important part of the warfighter's future and is becoming so.

Cables, satellite—all of them—are going to be important and I believe, personally, that the satellites have some real advantages. In fact, being competitive is important if, for example, the broadcasters don't move to a high-definition, high-quality signal, they are likely to become like AM radio is to FM radio. If cable doesn't produce a high-quality signal, it is going to be outrun by satellites. I happen to have both cable and satellite. And it is a signal that is so much better than the cable signal I receive at home today. I do have a good television set. It is ready for high-definition aspect ratios, and it has Mpeg-2—that is the modern compression scheme. The satellite folks are going to outrun these terrestrial systems if the terrestrial systems don't start running faster.

So I wouldn't worry about those folks. The more competition, the better off we are because the services that you and I and everybody in the world get in their homes, whether it's for education, entertainment, culture or communications, telemedicine, warnings, the wide variety of uses that are going to evolve. Those services are going to be more affordable for all of us, when companies compete and countries compete to provide it for us.

DR. DAILEY: Thank you. Dr. Stone, what do you see as the role of manned space exploration versus robotic exploration?

DR. STONE: I think they really serve complementary purposes. Human exploration is something which involves human beings going there, and ultimately, there's really no substitute for human beings going there. On the other hand, there's a great deal that can be done with robotic exploration. With Mars, for instance, it's very clear that the robotic exploration is very important for setting the stage because human exploration will be much more complex. That means we need to be sure, when we send humans to Mars, we take best advantage of their capability to explore the most interesting spots on Mars. That means we need to understand Mars a great deal better than we do today robotically before one would want to send the very precious resource of human explorers.

DR. DAILEY: Thank you. Mr. O'Neill: American businesses have downsized to the point where some of them are useless. How will NASA know when it has downsized enough?

MR. O'NEILL: I think we will restructure in the operations part of the business on the basis of the technology that allows us to restructure and still manage the risk appropriately. We are challenged to downsize in many of our processes simply to make the funds available for the development of the new programs, robotic spacecraft, human endeavors or whatever. I think we're developing really quite a good handle on our restructuring activity and the goals to go after. The review team activity over the past two years has given us a very solid basis.

I might say that perhaps the most important part of the review team activity is that it has involved people from other areas of the agency and, yes indeed, people outside the agency, and so we've developed a perspective and a methodology for looking at how we might approach restructuring. But we'll keep a careful eye out on it. We will report to Dan Goldin and our associate administrators, as appropriate, on our progress in these different areas.

I might go ahead and say that in operations we've, on occasion, been accused of being a little too afraid to make change. I'm going to turn that into a positive thing that we'll keep a careful eye out for not destablizing the important processes and yet take advantage of the technology, the smart ways to operate, and the things that industry can indeed do more cheaply for us, keeping those things firmly in mind and utilizing them.

MR. GOLDIN: Let me say this, we are not downsizing NASA. We are bringing NASA into the 21st century. When the term downsizing is used, it connotes a negative action. NASA is ripe with opportunity for restructuring for the next century. And people shouldn't be afraid of doing things that need to be done. There is no reason to operate a launch system with 35,000 people. In fact, it's a crime on the space program that that is what we're doing. There is no reason that we have marketing teams at each of our centers to keep the work flow going so that we can maintain stability in the centers. The object is to give the American public a space program that allows us to leave planet

Earth and to give the next generation of students in this world a future of opportunity. This is the direction we're going in.

. . .we are not downsizing NASA. We are bringing NASA into the 21st century.

Finally, NASA is not a place where we have 70 percent of the budget in operations related to facility maintenance. It's not a place where we should have people working on printing the circuit boards in the middle of the night on custom hardware when we should just go buy computers off the shelf. When the computer breaks down, bring the maintenance organization into NASA.

This is what we're doing. Don't be afraid. Let me tell you, there are companies that downsize and there are companies that look into the future. The companies that downsize get to the place that they deserve. The companies that look about going into the future will create new opportunities.

Don't be so afraid. People complained about change at NASA for almost a decade. Now that it's here, they're holding on to the past with an iron fist. Don't hold on to the past. Don't be afraid. It will be O.K.

DR. DAILEY: Thank you. Mr. Chen, a question for you. What do you feel China can best contribute to the Space Station effort, and I'll expand that to include international space cooperation and the civil space area itself?

MR. CHEN: We are grateful to have the great encouragement from the international space community. We will be very happy and excited when we see the Chinese astronauts flying in orbit.

Last night I had a talk with my friends from McDonnell Douglas at their exhibition booth. They said, one day, sooner or later, China will join in the International Space Station project. I think that is our hope. We will be very happy to contribute to the Station like the other countries.

I recently participated in the preparation for the signing of the MOU between China and Canada. I was told by my Canadian friends that they play an important role in the Space Station with their Canadian arm and other technologies.

In general, we hope to have friendly cooperation in the space arena with other countries and corporations. Specifically to the Station, I think our technologies in recovering payloads and in tracking, telemetry, and control are quite good. When the right time comes, we can have further discussions.

DR. DAILEY: Thank you. Mr. Doré, what is the age limit for your students? Do you train other than young students? And what does the one year master's program cost?

MR. DORÉ: At the Summer School last summer in Barcelona, we had 126 students. The average age was 28. For the master, the average age will be feasibly a little higher, most likely around 30 because most of these people are already in the space sector and they will enter the program with high academic qualifications and a few years of practical experience. Unfortunately, I don't have the exact statistics for '95.

In terms of cost, the tuition fee is $23,000 U.S. for tuition, only for the master. The Summer School fee is $13,000 at present. It includes, for the Summer School, the food and lodging; for the master it does not. You must understand we are a private university that is not being subsidized by any government, because then we would lose our independence. We want to keep that independence because this a crucial factor towards the success of ISU. Therefore, the tuition is similar to that of other private universities around the world.

DR. DAILEY: Thank you. Lon, when you say that the average man/woman is "shut out," what do you mean, and how can we make space more relevant to the average U.S. taxpayer?

MR. RAINS: I think the first thing I mean is that the average man and woman wants to go to space. They don't want to wait. They don't want to be voyeurs, they want to go and I think that, to the greatest degree that we can develop systems that will allow that to happen and start moving in that direction, you'll see greater public support.

DR. DAILEY: Mr. Goldin, would you like to comment on that at all?

MR. GOLDIN: I think the key is as Tom Rogers has said, "You have to get low-cost, safe, reliable, abundant access to space." This is absolutely the key. We have got to move as fast as possible.

We have a real problem. Every time we get close to the mark, all those interested in maintaining the status quo fight real hard to prevent it. This is an open book quiz for America as to whether or not we're going to make this RLV work, whether we'll get the funding we need, whether we'll trickle fund it or whether we'll fund it robustly, whether industry will step up and really try or whether industry will try and maintain the EELV fleet and pay lip service to the RLV. There are a whole bunch of conflicting forces here, and as the administrator of NASA, I have an obligation to the American people to make sure this goes forward. I'm going to do everything I can. From

the standpoint of NASA, there is no higher priority new start. As I testified in the Congress, if there's any more cutting of the NASA budget, we will cancel existing programs. But this will be the last. We're going to stop.

DR. DAILEY: Mr. Goldin, EOS appears headed toward another restructuring for smaller spacecraft size. When do you envision a right-size spacecraft so we begin building beyond AM-1?

MR. GOLDIN: Let me say this. We have taken EOS from $17 billion for this decade down to $7.3 billion for this decade. It would have been nice to have done it in an environment where people really recognize we owe the American public some money, but there was quite a bit of resistance every time we went to change the EOS program. So instead of doing so gracefully, we're doing it in a few fits and starts.

The problem we have is this: if you take a look at the EOS program and say we have three phases to it, one is to the end of this decade—maybe until 2003—where we launch 24 instruments and they operate for at least five years. Then phase two is another 24 instruments for five years, and phase three is another 24 instruments for five years. The tradition in America is first, when you develop something, the contractor gets the contract and they have a multi-decadeal contract. We do not want to do that with EOS because we projected the outyear funding and we built up a program that was bigger than Space Station. You project it out over the 15-year timeframe.

So we said, we're going to get the first EOS platforms launched and we're going to look closely at developing technology between now and 2000 that will let us get away from these medium-sized spacecraft and go to individual spacecraft. The object is to have one instrument per spacecraft, and see if we can coregister the pixels from these instruments.

We intend to run experiments in the next few years, not the next few decades, to prove this. And if we prove this is the case, the very minute we prove it's the case, we're going to start flying these. The other nice part about having one instrument and one spacecraft is the fact that, with this new technology, you could continually upgrade. You wouldn't get locked in to old technology and have the space program become an organic program sustained to protect the jobs of today.

The other nice feature of being able to do this is that there will be some fraction of these instruments that will be commercially interesting and viable. Instead of NASA having to go out and do things, the commercial industries will say, "Hey, why don't you become an active tenant, buy some data from us, we'll take care of everything." We'll be pleased to do that and ultimately just turn the whole thing over to the commercial sector.

We would like to see the remote sensing business go from $1 billion a year to $10 billion a year. It will never go to $10 billion a year if we award a prime contract on the common spacecraft buy and allow that to go for 15 or 20 years. We are going to get this thing going. I have no sympathy for maintaining stability. We're going to have the most advanced program in the world. We'll make the basic measurements; we're going to meet our obligations for the next five years. It'll take time to transition, but at the turn of the century, I'd like to see Darwin rule EOS.

We have a real problem. Every time we get close to the mark, all those interested in maintaining the status quo fight real hard to prevent it.

DR. DAILEY: Another one for Mr. Goldin. How can you say we are making progress on space when we cannot land humans on the moon as we were able to 25 years ago?

MR. GOLDIN: The object of going into space is not to go back to the moon and land humans again—to do what we've already done. I am not so sure that it's necessary to go back to the moon, but we need to explore that. We need to keep in mind the vision I just outlined.

DR. DAILEY: Thank you. Dr. Doré, I'd like to ask you a question with respect to the students you educate. As the moderator's prerogative, I think I'll pursue this line of questioning. The students really provide us with insights as to what they see the troubles are in the space program. Sometimes we often ignore them or don't really take notice of them. What are some of the items that are on the students' minds or the issues that are on their minds that concern them about the direction of the U.S. space program, and what kind of recommendations do they make, if any, in seeing how they could make it even more looked at as an important program for society?

DR. DORÉ: I don't think I'm in a position to really answer your question, because I did not, myself, participate in the past summer schools. The only thing I can say is that, from what I've seen in terms of reports, for example, for the space policies of the world and national space policies, is that in the environment of the summer school, they come up with ideas that are not bound to the constraints we usually work with. And it produces, sometimes, solutions that make a lot of sense, because in the process they were not bound

by such constraints. That's a very good question, but I don't have the answer.

DR. DAILEY: O.K. Mr. Rains, you have published a number of times in your newspaper some public opinion polls about what the Americans think of the U.S. space program. What are the kinds of things—to kind of elaborate on this issue—how does the United States and even others see the space program and its value? What are some of the recommendations that you would make that really aren't involved inside the beltway discussions but are really on the minds of Americans about where the space program's going and the problems it may have?

I don't know why there's such passion and emotion about canceling Medlite. We are going to go to Mars in '98 and 2001, 2003. We wanted a launch vehicle that could get us half the spacecraft there for half the cost. And that's what we did when we went out with the Medlite procurement.

MR. RAINS: I don't think it really is on the mind of Americans. I think the Americans like it; I think to some degree it is voyeuristic. There's entertainment value. There is certainly educational value. But I don't think it's a burning issue with the voters or with the public. As I've said, I think that the way that's going to happen is when people see that it is something for them and not just something for scientists or pilots or a very exclusive group of people. The people like the space program, but it's not a burning issue with the public at all.

DR. DAILEY: We have time for a couple more questions. Mr. Goldin, with NASA's charter in RLVs, will Medlite be canceled?

MR. GOLDIN: I don't know why there's such passion and emotion about canceling Medlite. We are going to go to Mars in '98 and 2001, 2003. We wanted a launch vehicle that could get us half the spacecraft there for half the cost. And that's what we did when we went out with the Medlite procurement.

What's been going on behind the scenes in trying to get that procurement canceled absolutely baffles me. We are going to use it. We awarded a contract that was bid competitively, and so long as it performs and we don't have anything better, we will use it.

DR. DAILEY: Finally, Mr. Johns, would you elaborate on the changes in the NASA organization that you would propose in the future to make it more efficient? Like, give us from the White House perspective.

MR. JOHNS: Dan Goldin will be pleased to hear that the White House has no intention of micromanaging NASA. We are supportive of the notion that NASA has to modernize. It has a job to do and a new agenda, and the American people have indicated they would like to have government cost as little as it possibly can. That message has put some urgency into trying to do this as economically as possible. We think Dan's on the right track.

DR. DAILEY: Thank you. I want to thank the audience for their patience. I think this is a very important symposium. Internationalization of space is clearly a future direction and will continue to be a future direction for the nation. I'd also like to thank Dave Payne for putting this all together and making sure it runs on time like a Swiss clock.

Again, thanks all of you for coming, and we look forward to seeing you tonight. Thank you.

MR. PAYNE: I'd like to thank the session speakers, particularly our friends who have come from far away, and especially our keynote speaker, NASA Administrator Dan Goldin. And a special thanks to Brian Dailey for moderating this session.

We do have a short video from ITT Aerospace Communication Division to show you their dynamic company. That will be followed by the reception, which is also sponsored by ITT Aerospace Communication Division. That will be in the Colorado Hall.

So if we can go ahead and start that video, please.

Space Technology Hall of Fame

Featured Speaker: **C. Michael Armstrong**
Chairman & CEO
Hughes Electronics Corporation

General James E. Hill, Dick MacLeod. The legendary Dr. Teller. Dignitaries from Space Command and the Air Force Academy. And in the space of this, the 11th annual National Space Symposium, none of us can underestimate the importance of this gathering as an intellectual intersection to face change and exchange ideas. To my mind, there's no better proof than the fact that this symposium unites people from every corner of the space community: civil and military, U.S. and international.

And this symposium is all the more important now, because we meet at a time of maximum uncertainty—an idea that is really inherent in this year's theme, "Vision and Reality: Face to Face." In that theme, there's a sense of an industry at a crossroads—if not at cross-purposes. And that's understandable. I think we all know that our approach to space, an approach catalyzed by the Cold War, has changed—has to change—if we are to realize our new future in space.

If some of the mystique and mystery that once surrounded our space efforts is a thing of the past, it's because the reality of our space efforts has become more routine.

But my purpose tonight is not to deliver a requiem for the Space Revolution. Anyone who is tempted to send flowers fails to see the window of opportunity now open to us.

I'll admit, that's not quite what we might see out our window right now. This week we've heard the general prognosis: A challenging forecast for government space programs and hopeful prospects for the commercial space sector.

In Washington these days it seems there's a continuing hit list with DoD or NASA's name on it. The landscape is littered with programs that are being stretched out, consolidated, or killed altogether.

But there are programs that each of us, if not all of us, should fight for—programs like EOS/DIS, an integral part of the Mission to Planet Earth. From their position in polar-orbit, EOS satellites will beam back a steady stream of data on our Earth, our atmosphere, and our oceans; information available to scientists not just here in the U.S., but also around the world. It's a sound example of the way our journey into space is an exploration into our own world, our destiny, and ourselves.

But the fact is, programs that were once sacrosanct are being caught in the cross-hairs. The sharp decline from the peak space budget is even steeper than the decline we've seen in defense. Space, as far as the budget battle is concerned, is now a target rather than a societal imperative.

Now, if all of this implies a kind of glass half-empty assessment, that is not what I mean to suggest.

We learned some time ago that technology in space can secure peace on this earth. We're learning now that space is a gateway not simply to peace, but to prosperity as well.

If some of the mystique and mystery that once surrounded our space efforts is a thing of the past, it's because the reality of our space efforts has become more routine. That's true—whether we're a businessperson communicating away from home, or an army on the move.

Take our experience in Desert Storm. Consider the daring end-run through the Iraqi desert that won the ground war—and the technology that made it possible. I'm talking about GPS. The desert is the closest thing our planet offers to a lunar landscape, with almost featureless terrain and few fixed points. U.S. forces and their coalition partners could never have executed that kind of ground attack—the swinging door that slammed shut on Saddam's front-line forces—without controlling the high ground of space.

We learned some time ago that technology in space can secure peace on this earth. We're learning now that space is a gateway not simply to peace, but to prosperity as well.

We all know the fall of the Berlin Wall was the last gasp of communist ideology. But it was something more as well: It was a victory for a communications revolution whose full effects are only now beginning to register—and reverberate—through our world.

From the cave wall, to the log drum, to the twisted pair, to the signals that arc across the vastness of space, we have always sought a better means to speak our mind, to share our ideas, to advance our thoughts.

But just as the Cold War and the quest for the military high ground sparked the race for space, so, too, it took the end of the Cold War to clear the way for the true commercialization of space.

Every day, we see the consumerization of space becoming a reality. The GPS system I mentioned a moment ago in regard to Desert Storm: Last month our Delco Electronics business unveiled its new, low-cost Telepath in-car navigation system. Its an in-the-dash integrated approach with street matching and directional guidance, and even an electronic Yellow Pages, made possible by the same GPS satellites.

I submit that the commercialization of space, the communications revolution, and the globalization of markets go hand in hand.

Without beating around the bush, the reason I'm enthusiastic about the future is that space is becoming a competitive place to do business. And it's because the space industry is driving significant change—delivering break-through technology and dramatically improving performance. The difference today is that it's getting all this done with costs that are affordable to the investor, prices that are competitive to the market, and returns that are attractive to the shareholder.

Every day we see new evidence that Space is the new media for modern life. At Hughes, in recognition of this reality, we've set our sites on a vision we call the Wireless Expressway. In contrast to the images of an Information Superhighway stitched together by cable and wire, we are constructing an "instant infrastructure"—a portfolio of space-based systems, that, once deployed, put whole countries and continents on- line. Not only on-line instantly for everyone, every place they beam, but also delivering a ubiquitous, affordable service to those that need as well as to those that have. Telephony where telephones haven't begun; communications mobility where wires cannot serve; bandwidth-on-demand where distance learning, teleconferencing, and telemedicine make a difference in our society and between our societies.

We tend to believe that the shortest distance between vision and reality is often a satellite in orbit. As we implement this vision, the once-sharp line between civilian and military use of space has become blurred. Imagine the mobile cities of people we call modern armies, the floating cities we call carriers, and the air assets that project power around the globe. Imagine the use they could make of this instant information infrastructure. We have a significant opportunity to exploit new synergies in space technology—an opportunity with profound impact for both peace and prosperity.

But there will be no reality to this vision unless we do execute Dan Goldin's challenge: faster, cheaper, better. In fact, this challenge is the very underpinning of applying space assets to new applications, both for commercial and government markets. The key . . . is affordability. The laws of economics work every bit as much in a gravity-free environment as they do on Earth: Affordability opens the door to market acceptance and demand elasticity.

Without beating around the bush, the reason I'm enthusiastic about the future is that space is becoming a competitive place to do business. And it's because the space industry is driving significant change—delivering break-through technology and dramatically improving performance. The difference today is that it's getting all this done with costs that are affordable to the investor, prices that are competitive to the market, and returns that are attractive to the shareholder.

We see proof of this in the power, payload, propulsion, and performance of today's satellite technology.

In payload power, there's been a four-fold increase in less than 10 years, and we're confident we'll see an additional two-fold-plus increase within the decade ahead.

In payload capacity, we now deliver multiple payloads for C-, Ku-, and L-bands—capacity that permits a single satellite to offer multiple applications from broadcast to mobile communications to personal networks.

In propulsion, our new Xips (pronounced Zips) ion propulsion system, scheduled for launch later this year, will reduce the weight of the system while increasing the life of the satellite. Xips brings the weight of our 601 satellite down by 800 pounds—a savings of $10 million dollars per launch. This gives the customer the right kind of flexibility: Take the weight reduction to lower cost, or hold the cost constant and add capacity.

And in performance, for the 100-plus communications satellites we've launched since 1963, Hughes' transponder channel availability exceeds 99.4 percent. A terrific customer service record that's only going to get better.

The trajectory of these technological advances is critical, because when it comes to new government applications, our commercial space effort can offer important lessons learned. Part of it is just due to the nature of the market system. On the commercial side, we live on a diet of fixed price contracts. We've got to be competitive on a month-to-month, day-by-day basis: We can't expect to win a few platforms and live off of them for years.

In a commercial competition, the norm is two to three month's compete time, with launch 18 to 24 months later. Cycle times are short and growing shorter, and the distance between technology development

and manufacturing is closing fast. These trends mean bottom line—faster, cheaper, better.

Not only is technology making this a reality, markets are converging and also making it a reality. Traditionally, government sought and bought technology—state of the art, with performance the priority. The commercial sector, in contrast, often sought economy, but only as much technology as the customer wanted and could pay for. Today, both markets are cost-driven, just as both of their customers clamor for new technology.

Traditionally, we have looked for dual use opportunities, and we should. But today, it's a two-way street, where we also find commercial feedback into defense systems. We used to speak about spin-offs; we now see spin-backs. Not just the modern equivalents of Teflon and Tang, but technologies at the cutting-edge of change. Technologies that can boost morale, win wars, save lives.

Take Hughes' Spaceway system, for example. This will be an interactive, global satellite network that will offer high-speed voice, video, and data transmission up to 150 times faster than conventional telephony. As just one measure of what Spaceway will do, consider telemedicine and the transmission of digitized X-rays. Right now, sending an X-ray over the phone line takes an average of 21 minutes. Spaceway will take that transmit time down to 8 seconds.

But my point is this: We didn't depend on government dollars to get Spaceway started. We've taken the pulse of the marketplace and see the need for a commercial version of the Milstar system the government spent 10 years to put in place.

And when Spaceway is up and running in 1998, we anticipate the military will literally lease space as needed. No upfront cost. No 10-year wait. No deployment of scarce resources long before you need the service. That's the beauty of Spaceway's bandwidth-on-demand.

We see the same opportunities today with DirecTV, our satellite-based 150 channels of TV to an 18-inch dish. Last November I had the honor of visiting the USS Abraham Lincoln to inaugurate our first ship-based DirecTV system. Now, we're working with the Navy to bring that service to every ship in the fleet.

Yes, having DirecTV on board means watching the Lakers play the Nuggets live without having to wait for Mom or Dad to mail out a videotape. And that matters; it matters because morale is a key to military preparedness.

But the shipboard telecommunications link I'm talking about is important in ways that go well beyond its entertainment value. Look at the capabilities for distance learning: Connecting instructors and trainers to crew members by television. Look at the capability for telemedicine: What happens when a service member falls ill or is injured at base or in battle? In those first few hours when medical treatment is critical, it's faster, it's easier, and it may save more lives to beam a specialist in from Walter Reed than to get a sick service member to the specialist. With 63,000 patients airvac'd a year, this technology should make a difference.

I've used the Navy to illustrate the kind of new applications DirecTV makes possible: But it should be clear that this technology promises benefits to the forces of every service in many circumstances.

It all starts with asking questions. If we can get 150 channels of bandwidth on our television, what can we do with 150 channels in a tank? How about in a tent, or my truck, or a foxhole, or in the cockpit?

Given the convergence of space technologies, given commercialization's impact on costs, space is a competitive place to do business today, whether we are multiplying force structure, or serving market forces.

But the comprehensive change that is needed cannot come from industry alone. We must see a parallel shift in space policy from the halls of Congress to the E Ring of the Pentagon to Foggy Bottom and NASA.

Up to now, I've spoken about the way the market is driving change, and the way industry is responding. But the comprehensive change that is needed cannot come from industry alone. We must see a parallel shift in space policy from the halls of Congress to the E Ring of the Pentagon to Foggy Bottom and NASA. First, I'd like to challenge our customers, NASA and the JCS, to accelerate realizing the commercial space potential.

NASA is looking at outsourcing and importing commercial practices. The JCS are looking at jointly building information and communications systems and using the commercial market to help get that done. These are positive changes, changes I applaud, and I assure you industry will support.

Second, the Cold War may be over, but too many of the old policies live on. For example, we must end the U.S. Cold War practice of unilateral economic sanctions. The annals of history do not provide a single example where unilateral economic sanctions worked. In most cases, the target country finds a way to get the technology, and third-country industry, unaffected by sanctions, gets the sale. That's what we've seen in the State Department's sanctions against commercial communications satellites launched in China.

Commercial communications satellites should not be on the munitions list. They are irrelevant to missile proliferation or threat of technology transfer. Including them on the munitions list simply costs us

exports and jobs. State Department sanctions are the most significant competitive advantage our European satellite competitors possess. It's a policy that must be addressed if the American aerospace industry is to continue to globally compete.

And third, we've got to make our voice heard and our views known as Washington rewrites telecommunications policy. This may not sound like an issue for many in the audience today, but it's part of the post Cold-War changes I'm talking about. Phone, cable, and fiber are all weighing in on this debate: We need to make certain wireless technologies are fairly considered as the new rules for the Information Superhighway are written.

In the area of video distribution, we must ensure continued equal access to programming. Without equal access, there can be no competitive distribution system. Vertical integration of the industry would quickly prevail, a few mega-companies would rule, and chaos at the consumer level would result.

Also, as the FCC and Congress try to define just what is "effective competition" in the cable industry, as they consider deregulation, I would urge them also to address the networks, which everyone seems to agree should continue to be regulated. If cable companies are going to be permitted to package and price upper-tier programming on an unregulated basis, then for satellite and telephony to be competitive, the networks should be offered on a regulated, stand-alone price basis.

And finally, while the PCS spectrum auction was appropriate and successful for local licensees, a similar approach to spectrum that is satellite-based and/or international in scope would be a disaster for the U.S. commercial satellite industry. Not only would we have an unfair tax, versus terrestrial technology, but it would provoke an international space trade war that would decrease the commercialization of space and limit international market access.

I am encouraged that the FCC and Congresspeople I talk to are supportive on these issues, but until legislation or regulations are determined, we must speak out and secure fair and equitable policy.

Ladies and gentlemen, my message tonight is quite straightforward. We have an exciting and rewarding future as we make space a competitive place to do business. And as we deliver faster, cheaper, better, we need to

- accelerate commercial application to public and military use,
- ensure technology transfer is a two-way street, and
- stand up for the changes in telecommunications deregulation that results in fair and balanced policy.

It's been more than 20 years since Neil Armstrong took one giant step for mankind. There were times since then when we may have lost our sense of mission that motivated the space program. As paradoxical as it may seem, we are regaining our sense of excitement and energy about the potential of space. Space is still the high ground—a new frontier where we explore a world far beyond our own, a journey that ultimately brings us back to ourselves.

I believe we are poised to take another giant step into a space-based future that brings us peace and prosperity for years to come. Thank you.

The Outlook for Space

Featured Speaker: **General Ronald R. Fogleman**
Chief of Staff, U.S. Air Force

Space - Our Foundation for Today and Tomorrow

It's a real privilege to be back in Colorado Springs. I've done two tours here, and still I find this an exciting place. One of the things that has always impressed me is the history of this city. It is filled with all kinds of stories about pioneers, like Zebulon Pike, who came here in 1806. There's also General William Palmer who developed this city in 1871.

And, as I look around this room, I recognize that I am in the presence of living pioneers. I see General [Bernard] Schriever and others who have been real pioneers in space. We are not in a situation where the pioneering era is behind us. I think we're in mid-stride. And, we're advancing not just this nation's, but mankind's interests in what lies beyond the earth's atmosphere. So, I am very honored that General Jim Hill invited me.

I do want to tell you one thing up front. When I got involved in the programming business in the early 1980s, I kept running into the space portion of our budget. Obviously, at the time, I didn't know much about it. There was a young colonel in the building at the time by the name of Tom Moorman. He came to my help and started giving me lessons—space 101, 102, and field trips. As a result of that, I became a supporter of space programs. I don't say that to be condescending. But, I mention it because I had the opportunity to see, in the beginning, the promise for much of what has now come to fruition.

Secretary Widnall has shared the status of our space initiatives with you, so I won't go into those details again. The thing I would like to talk about, though, is something the Air Force is doing that I am very proud of. To appreciate what I'm talking about, I need to put it in perspective.

It starts with the fact that our defense budget is down. That's no surprise. And, for the Air Force, our modernization account has fallen something like 60 percent over the past decade. You know what that means. There's great competition for dollars in the budget. As the chief of staff, I spend my time trying to balance what these dollars buy for near-term readiness, force structure, and modernization. We have this compelling interest to maintain readiness. And, certainly, we must maintain our force structure. But, I will also tell you that we must modernize for tomorrow.

But, despite the decline in our modernization account, the Air Force has two new acquisition programs in our current budget. Both involve space programs. I am, personally and professionally, very proud of this. The evolved expendable launch vehicle and the space-based infrared system are critical for this nation to maintain our edge in space. I am very optimistic that these initiatives will be model programs. I say this for a couple of reasons.

First, we are building a foundation of trust and teamwork—a shared confidence with industry. I will tell you that Secretary Widnall and I view industry as full partners on the Air Force team. We recognize the need to take bold and innovative proposals to make EELV and SBIR systems a reality. Your commercial and civil ventures give you tremendous expertise and knowledge. You don't need us telling you how to build a better mouse trap or a better spacecraft. So, what we are going to do in these programs—and across our procurement programs—is tell you what we need and let you figure out how best to build it. I see it as a cooperative effort. I think it's the right approach.

. . . despite the decline in our modernization account, the Air Force has two new acquisition programs in our current budget. Both involve space programs.

As a historian, when I look back on the history of this nation, we have been successful and on the leading edge of any activity when government and industry worked in a cooperative, not confrontational manner. So, viewing industry as a trusted partner on the Air Force team is a major initiative on my watch.

Second, we are serious about reducing the cost of doing business with the Air Force. We are doing this several ways, but I will mention just two efforts. Certainly, as I have traveled around and talked to the leaders of various industries, it has become clear to me that we have too much oversight. In some cases, we have too many people who just drop in to visit. All of this drives a certain amount of overhead and administrative costs. In one case, a CEO told me that at his complex, he had over 12,000 visitors in one year. Now, I've got to tell you, we were not doing enough business with that individual to generate 12,000 visitors in one year. This is an example of us having too many visitors. If we're going to be serious about reducing costs, we've got to get out of the tourist business.

So, if you have too many Air Force folks just dropping in, let me know. I know how to solve this problem. As an old programmer, I know that if you control their dollars, you control their hearts and minds. We're going to work this issue.

Second, we're streamlining the procurement process itself. I think the EELV is a good example. We're looking at operating in a paperless environment. You sit there and think, "Geez General, it's about time you guys started thinking this way. We've been doing this for some time." And, I think we're finally getting the clue. We've done this most recently with our JAST program—the Joint Advanced Strike Technology program that we are doing with the Navy. I'd like to give you an update of how the JAST program is moving forward, to save time and money.

In February of 1994, the JAST office issued a request for concept exploration studies. It was a first step in designing an aircraft. To speed up that process, they required all contractors to submit proposals electronically. And they received 154 separate proposals. Using the old methods, the JAST program office calculated that it would have needed 13 weeks to evaluate the proposals. It would have employed four clerks, and it would have had to find a way to store over 130,000 pages of documentation.

The bottom line is that the paperless process is faster, it is more responsive to new ideas, and it costs less.

But, by using the electronic medium, the JAST program awarded the contract in two weeks, employed one clerk, and used no paper at all. The entire process—from concept to contract—took only four months. Now, if it had used the established methods, it would have taken over a year. When you crunch the numbers, you'll see that the paperless process reduced the time required by 60 percent. What I have discovered in talking with industry CEOs is that time is money, because time multiplied by people is dollars. And, if we are doing business with you, we're paying for that time and these people. The bottom line is that the paperless process is faster, it is more responsive to new ideas, and it costs less.

So, my point is that we're trying to make strides in our procurement practices. And we need to. Particularly, I think, in the space business. As I told you a moment ago, I am great supporter of our space programs. And, if we are to sustain our space operations and leadership, we've got to modernize our space forces. At the same time, we've got to be able to do it in an efficient and prudent manner. This is important, not just to the United States Air Force, but to the nation as a whole. Let me explain why.

When the Berlin Wall came down, we found ourselves in a situation where the nation needed to change its national security strategy. It was here, in Colorado, on the second of August, 1990, that President Bush enunciated a new security strategy. This strategy reduced our overseas basing. We would maintain enough forward presence to facilitate the introduction of troops if we needed to come to the aid of allies, to provide humanitarian assistance, or to defend a vital U.S. interest. At the same time, we would build a continental-based contingency force. As a result, this strategy created new demands. It put an increased emphasis, in my view, on space architecture and space forces. These forces allow us to remain engaged worldwide, everyday. Our space-based assets give this nation a degree of global situational awareness that no other nation has. As such, I see these assets providing our nation a unique form of global presence from the high ground of space. We monitor events and provide timely information—24 hours a day, anywhere in the world.

It hasn't always been that way. In one sense, I look back and think I have had a very short career. In another sense, due to the particular time frame that this 31 years has spanned, I've seen a tremendous change. In the early '60s, when I was first commissioned, space was an arena dedicated to research and development. Then, by the early '70s, when I was on my second trip into Southeast Asia, I saw how satellites started, in a very rudimentary way, to support the warfighter. Primarily, they provided weather data. By the end of the '70s, our space assets were becoming critical to mission planning and communications. They played a part in the failed Iranian rescue attempt. As we entered the '80s, space forces gave us a much broader global situational awareness. For example, space permitted us to monitor the Iran-Iraq conflict. We gained a lot of valuable information in this manner. And then, of course, as everyone knows, Desert Storm was the place where space and terrestrial forces were highly integrated for the first time.

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Desert Storm was interesting. I have a lot of personal experience, not in the desert, but as the air component commander in Korea at the time. I sat there with a guy who I happen to think is probably one of the greatest joint commanders that you'll ever run across—General Bob RisCassi. He and I monitored what was going on in the Gulf. We found it fascinating. I could go up to the Hardened Tactical Air Control Center in Osan. My troops could show me, in real time, the enemy order of battle—what sites were emitting and what sites were not. These were things we had never thought about before. It was a capability that had existed, but the fact of the matter is that we didn't know that the architecture existed so this information could be sent around the world.

So, when the war was over, General RisCassi said, "Ron, get a hold of the people at Space Command and have them tell me what they did for General Schwarzkopf. And, then I want them to tell me what it would take to build the same capability here." Well, an interesting thing happened. They brought a survey team out from Space Command. They looked at what we had in Korea. They said, General RisCassi, you have, in place on the Korean peninsula, everything it took us five months to build up for General Schwarzkopf." But, we were ignorant of that. For example, on the third hole of the [Osan Air Base] golf course, there was this antenna farm. We knew that if we hit a golf ball in there, we couldn't go in and get it. It turns out that it was one of five downlink stations for DMSP [Defense Meteorological Satellite Program]. We had this capability all along. What had happened over the years is that a lot of folks looking for a place to prototype equipment had brought it to the Korean peninsula. So, it really drove home for me how disconnected we were in understanding space. And, I will tell you, that the progress we've made since the war in the desert is just astounding.

I think that space, in and of itself, is going to be very quickly recognized as a fourth dimension of warfare. Desert Storm left no doubt about that. And, yesterday, Jeff Harris, assistant secretary of the Air Force for Space, talked to you about Information Warfare. He described the tremendous advancements we're making in this area. And, because of the rate at which this information technology is moving forward, I think information warfare is becoming a fifth dimension of warfare. Computer capacity is increasing. In fact, it's doubling every 18 months. It is moving forward at such a rate that no one can afford to not be in the game. So, in a global sense, everyone is going to become dependent on this information flow and exchange. From that, you get both strengths and vulnerabilities. That's why information warfare—understanding it and being able to exploit it—will be critical. From my study of the history of warfare, I know that successful people are those who can—through manipulating information—detect, plan, react, and strike—faster than the other guy. That's what information warfare and space does for us.

This potential for information operations has been obvious all along. If you go back to the Second World War, the allies used disinformation as a weapon. You remember [General George] Patton was part of a disinformation campaign before the Normandy invasion in 1944. At the time, it was a very rudimentary operation. The allies set up a fake Army headquarters and made fake transmissions. They knew what the other side's capability to intercept was and played to that. As a result, the Nazis ended up with a significant number of troops in the wrong place.

It is with this perspective that I think you can see how information warfare can be a tremendously high leveraging tool for today and tomorrow.

We are moving forward to realize this potential with a number of our programs. We have our TALON programs that are beginning to pay dividends for us. We have other assets too. We have the GPS [Global Positioning System] that gives us a tremendous capability, not only in navigation, but also in targeting and other data. MILSTAR and DSCS [Defense Satellite Communications System] provide us both tactical and global communications. DSP [Defense Satellite Program] and ALERT are contributing to missile warning and tracking. We use weather satellites for accurate meteorological data. And, the whole array of intelligence, reconnaissance, and observation satellites—all of these forces are dedicated to getting data from the origin to the decision maker.

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And, we're working to ensure the warfighter gets the same information, just as fast. We are dramatically reducing the time from detection to destruction of a target. Computers, comm networks, and airborne sensors, like Joint STARS, play an important part in what I've described. But, this potential of dominating the information medium is simply not possible without space.

Some audiences might consider that the things that we talk about—our capability today and what we project for tomorrow—as unbelievable. But, certainly not this audience. Throughout my years of service, I've learned that space is the place where a vision becomes a reality. I've always admired those people who have had the vision to move us forward. You are the pioneers who take the risks, who make the sacrifices, who think boldly, and capture the promise of space. This has been the case ever since Doctor [Robert] Goddard first launched a liquid-fueled rocket in March of 1926.

And, it goes back farther than that. Think back to Jules Verne's book *From the Earth to the Moon*, written in the 1860s. He described how, someday, we would put man on the moon. At the time, his work was called science fiction. Today, he is a prophet. The only problem is what Jules Verne misjudged. He misjudged not that man would walk on the moon—but that the entire world would watch . . . on television . . . LIVE!

If anything, we may continue to miss the mark. If we err, I suspect that we will not be thinking boldly enough about what air and space will do. And, I hope that this is the crowd that will help us go beyond the visions that are constrained by the minds of more conventional thinkers.

Featured Speakers

C. Michael Armstrong is chairman of the board and chief executive officer of Hughes Aircraft Company and Hughes Electronics Corporation which is comprised of Hughes Aircraft and Delco Electronics Corporation. Before joining Hughes in 1992, Armstrong rose through the ranks at IBM Corp. where he became senior vice president and chairman of the board of IBM World Trade Corp., which is responsible for IBM operations outside the United States. He has a B.S. in business and economics from Miami University of Ohio, and completed the advanced management curriculum at Dartmouth Institute. He supports higher education as a trustee of Johns Hopkins University, chairman of the Advisory Board of Johns Hopkins Medical School, and member of the Advisory Board of Johns Hopkins' Applied Physics Laboratories. He is currently a member of the Council on Foreign Relations, the National Security Telecommunications Advisory Committee, the President's Export Council, and the Defense Policy Advisory Committee on Trade.

Gen. Joseph W. Ashy, USAF, is commander-in-chief, North American Aerospace Defense Command and the unified U.S. Space Command, and commander of the Air Force Space Command at Peterson Air Force Base, Colo. General Ashy entered the Air Force in 1962 through the Air Force Reserve Officer Training Corps upon graduation from Texas A&M University. He earned his wings in 1964 and began his flying career in the F-100. His military career includes assignments in England, South Vietnam, Washington D.C., Arizona, Texas, South Korea, Utah, Alabama, California, Nevada, and Virginia. During his tour in South Vietnam, he flew 289 combat missions. He has also served as commander of the United States Air Force Tactical Fighter Weapons Center at Nellis Air Force Base, Nev., the Air Training Command at Randolph Air Force Base, Texas, and Allied Air Forces Southern Europe (NATO) and 16th Air Force in Naples, Italy where he directed the air operation over Bosnia. He has been in his current position since September 1994. His military decorations include the Defense Distinguished Service Medal, Distinguished Service Medal, Silver Star, Legion of Merit with oak leaf cluster, the Distinguished Flying Cross with oak leaf cluster, Defense Meritorious Service Medal, Meritorious Service Medal with two oak leaf clusters, Air Medal with 13 oak leaf clusters, Air Force Commendation Medal, Vietnam Service Medal, and the Republic of Vietnam Gallantry Cross with palm.

Gen. Ronald R. Fogleman, USAF, is chief of staff of the Air Force, Washington, D.C. After he graduated from the United States Air Force Academy with a B.S. he instructed student pilots; performed combat duty as a fighter pilot and high-speed forward air controller in Vietnam and Thailand; was a history instructor at the Air Force Academy; and conducted flight operations in Europe, including duty as an F-15 aircraft demonstration pilot for numerous international airshows. He has more than 6,000 flight hours in various aircraft. He has been commander-in-chief of the U.S. Transportation Command and commander of the Air Force's Air Mobility Command. His career has included assignments in Oklahoma, Arizona, Ohio, Colorado, West Germany, Netherlands, Washington, D.C., Utah, Virginia, Florida, Korea, and Illinois. He holds a master's in military history and political science from Duke University and graduated the Army War College in Carlisle Barracks, Pennsylvania. His decorations include the Defense Distinguished Service with oak leaf cluster, the Distinguished Service Medal, the Silver Star, the Distinguished Flying Cross with oak leaf cluster and the Purple Heart. He is a Fellow of the Inter University Seminar on Armed Forces and Society.

Daniel S. Goldin became NASA's ninth administrator after 30 years in the aerospace industry. Under his leadership, the Discovery Program, an entirely new class of planetary probes, was inaugurated. The goal of the program is to reduce development time to less than three years and mission costs to less than $150 million. He has launched a series of reforms to make the Agency more businesslike and has moved boldly to promote significant new cooperative endeavors with the Russian Space Agency, making them a full partner in the International Space Station. His other challenges have included a redesign of the Space Station to reduce costs, identifying the environmental monitoring to be done through NASA's Mission to Planet Earth as one of the Agency's most important programs, the repair of the Hubble Space Telescope and implementing President Clinton's plan to revitalize the aeronautics program which includes increasing investments and technical progress in general aviation, subsonic transports, supersonic and hypersonic flight technology, and the revitalization of aging research facilities such as wind tunnels. He earned a B.S. in mechanical engineering from the City College of New York and is a Fellow in the American Institute of Aeronautics and Astronautics and in the Institute for the Advancement of Engineering.

John S. Hendricks is the founder, chairman of the board and chief executive officer of Discovery Communications, Inc. The corporation owns and operates cable television's The Discovery Channel, The Learning Channel, Animal Planet, Quirk, and the Discovery science network. Hendricks also serves as chairman, Board of Governors, National Academy of Cable Programming; member, board of directors, University of Maryland Foundation; member, James Madison Council, Library of Congress; member, National Council, National Museum of Natural History, Smithsonian Institution; member, board of directors, Cabletelevision Advertising Bureau; and member, advisory board, Lowell Observatory. He founded and also served as president of the American Association of University Consultants. He was the director of Corporate Relations for the University of Maryland where his efforts generated corporate and foundation contributions totaling $7 million annually. He also has served as director of Community and Government Relations for the University of Alabama in Huntsville. He graduated magna cum laude with a bachelor's of science in history and an honorary doctorate from the University of Alabama in Huntsville.

Capt. James A. Lovell, USN (Ret.) was the commander of Apollo XIII and the first man to journey to the moon twice. He also commanded the Gemini 12 mission with pilot Buzz Aldrin and has logged more than 6,500 hours of flying time, 4,000 of that in jet aircraft. After retiring from the Navy and the space program he joined the Bay-Houston Towing company which is involved in harbor and coastwide towing, mining, and marketing of peat products for the lawn and garden industry, and ranching. He then served as chief executive officer of Fisk Telephone Systems until it was acquired by the Centel Corporation where he became an executive vice president and a member of the board of directors before his retirement in 1991. He holds a bachelor of science from the U.S. Naval Academy and eight honorary doctorates from such schools as Blackburn University, Rockhurst College, and Milwaukee School of Engineering. He is a Fellow of the Society of Experimental Test Pilots and the American Astronautical Society. His honors include the Presidential Medal for Freedom; the NASA Distinguished Service Medal, twice; and two Navy Distinguished Flying Crosses. He is the Chairman of the National Eagle Scouts Association and is an Eagle Scout himself.

Dr. Edward Teller is director emeritus of the Lawrence Livermore National Laboratory. Recently, he has been lecturing and writing books including, Better a Shield than a Sword (1987) and Conversations on the Dark Secrets of Physics (1991). He is best noted for his work on the development of nuclear explosives and for his advocacy of a strong defense for America. He is also noted for his more than 100 technical publications, books, and patents. He received his Ph.D. in physics at the University of Leipzig in 1930. With the rise of Nazi Germany, Teller left Hungary to work in London and Copenhagen, becoming a U.S. citizen in 1941. The possibilities of fission, together with the menace of the Nazi's led to Teller's work on the Manhattan Project. Teller was appointed a professor of Physics at George Washington University, Washington D.C. in 1935. He has held positions which include senior research fellow at the Hoover Institute and associate director emeritus at Lawrence Livermore Institute. In 1982, he was appointed a member of the White House Science Council. Teller is the recipient of many honors and medals for his work and contribution to scientific developments and to the defense of western democracy; these include the Albert Einstein Award, National Medal of Science and the Presidential Citizens Medal.

Dr. Sheila E. Widnall is Secretary of the Air Force. She is responsible for and has the authority to conduct all Department of the Air Force matters including recruiting, organizing, training, administration, logistical support, maintenance and welfare of personnel. She previously served as the Air Force Academy Board of Visitors member, and on advisory committees to Military Airlift Command and Wright-Patterson AFB, Ohio. Dr. Widnall, a faculty member of the Massachusetts Institute of Technology for 28 years, became an associate provost at the university in January 1992. A professor of aeronautics and astronautics, she is internationally known for her work in fluid dynamics, specifically in areas of aircraft turbulence and spiraling airflows. She was the director of the Fluid Dynamics Research Laboratory from 1979 to 1990. She holds a B.S. and M.S. in aeronautics and astronautics from MIT and a doctorate from MIT. Her awards include the Lawrence Sperry Award from the American Institute of Aeronautics and Astronautics; the Outstanding Achievement Award from the Society of Women Engineers; and the Washburn Award from the Boston Museum of Science.

PROGRAM PARTICIPANTS

Lt. Gen. Patrick P. Caruana, USAF, is vice commander of Air Force Space Command, Peterson AFB, Colo. He enlisted in the Air Force in 1957 and became a C-119 crew chief, received an Air Force Academy appointment and graduated in 1963. Gen. Caruana is a command pilot, having flown more than 5,000 hours with 500 combat hours in the C-123 and KC-135A. His military career has included assignments in Illinois, Colorado, Oklahoma, Ohio, South Vietnam, Alabama, Michigan, Japan, North Dakota, and Saudi Arabia. As Air Force Space Command's first 14th Air Force commander he directed the Air Force's only space force which supports warfighting worldwide with ballistic missile warning; control of Department of Defense and NATO satellites; spacelift generation and range operations; global space surveillance and warning; and ballistic missile test operations. He has been in his current position since August 1994. His military decorations include, the Legion of Merit with two oak leaf clusters, the Distinguished Flying Cross and the Meritorious Service Medal with two oak leaf clusters.

Chen Baosheng is the chief executive officer of China Great Wall Industry Corp., Washington, D.C. office. Mr. Chen is also the permanent director of the board of directors for the China Association for International Exchange of Personnel; a professor of environment management at the College of China; a member of the Expert Committee for the China International Engineering Consulting Corp.; and a special research Fellow of the National Natural Science Foundation of the People's Republic of China. He has served as the director of the Department of Personnel and Labor; the State Science and Technology Commission of the People's Republic of China; and minister and counselor for Science and Technology in the Chinese Embassy of the United States. He received a bachelor of science from the Department of Technology Physics, University of Science and Technology of China, Beijing, China and is a Honorary Fellow of the Washington Academy of Sciences.

Dr. France Anne Córdova is NASA Chief Scientist. She is the administrator's senior scientific advisor and the principal interface between the administrator and the national and international science community to ensure that NASA programs are universally regarded as scientifically and technologically well founded and are appropriate for their intended applications. Before joining NASA in 1993, Córdova was the head of the Astronomy and Astrophysics Department at Pennsylvania State University. She has also been the deputy group leader at the Space Astronomy and Astrophysics Group and staff scientist of the Earth and Space Science division of Los Alamos National Laboratory, New Mexico. She holds a bachelors degree in English from Stanford University and a Ph.D. in physics from the California Institute of Technology.

Dr. Brian D. Dailey is the sector vice president for Business Development and Washington Operations for Lockheed Martin Space and Strategic Missiles Sector and a member of the Board of Directors of Lockheed-Khrunichev-Engeria International, Inc. Before his appointment he was vice president of Lockheed Commercial Space Company and director of commercial programs for Lockheed Missiles an Space Company, Sunnyvale, Calif. Before Lockheed he was the executive secretary to the National Space Council and served as senior professional staff member at the Senate Armed Services Committee. He also served the Department of Defense and research institutes in various capacities including a professorship at the U.S. Naval Postgraduate School where he taught courses on intelligence programs, space policy, arms control, and nuclear targeting. He holds a Ph.D. in international relations from the University of Southern California.

Vice Admiral Walter J. Davis, Jr., USN, is director of space and electronic warfare. He received his commission in 1959 through the NROTC program at Ohio State University where he earned a B.S. in electrical engineering. He was designated as a naval aviator and has over 3,500 flight hours and over 800 carrier landings. He has commanded the VF-114 squadron; the USS Sacramento during WESTPAC, NORPACFLEXOPS, and FLEETEX-83 exercises; the USS Ranger deployed to the Western Pacific; the Carrier Group SIX and Forrestal Battle Group deployed to the Mediterranean to support Provide Comfort operations over northern Iraq; and the America Battle Group. He holds a B.S. and M.S. in aeronautical engineering from the Naval Postgraduate School. His honors include the Legion of Merit, twice; Meritorious Service Medal; Air Medal, 10 times; Navy Commendation Medal with Combat "V"; and the Navy Expeditionary Medal with three Bronze Stars.

Jean-Jaques Dordain is associate director for Strategy, Planning and International Policy at the European Space Agency. He joined ESA in 1986 as director of Space Station Utilization and Microgravity Programs. Dordain was a research engineer at the National Office of Aerospace Studies and Research for 15 years. His research fields include fluid mechanics, combustion, rocket engines and launch vehicles. From 1972 to 1992 he was a professor at the École Polytechnique and École Nationale Supérieure et de l'Espace. Dordain is a member of the International Academy of Astronautics, European Science and Technology Assembly and the Comité des Applications de l'Académie des Sciences and the Académie Nationale de l'Air et de l'Espace.

Dr. Roland Doré was named the president of the International Space University in Strasbourg, France in October 1994. Before that he was the president of the Canadian Space Agency to which he was appointed by the Prime Minister of Canada in May 1992. He received his first engineering degree from the École Polytechnique of the Université de Montréal where he later occupied various professorial and administrative positions such as Dean and Director of Research, principal and chairman of the board. He received an M.S. and a Ph.D. in mechanical engineering from Stanford University. He has been awarded the Julian C. Smith Medal from the Engineering Institute of Canada, the Centre's medal from the Centre Jacques-Cartier, le Grand prix d'Excellence from the Ordre des Ingénieurs du Québec, and he became an Officer of the Order of Canada for his significant contribution to Canada.

Steven D. Dorfman is president of Hughes Telecommunications and Space Co., senior vice president and member office of the chairman of Hughes Electronic Corporation. Before his appointment in October 1993, he was president of Hughes Space and Communications Company and president and chief executive officer of Hughes Communications, Inc., which is responsible for owning and operating communications satellites. Dorfman joined Hughes in 1957 holding positions in management, systems engineering, and elector-optics. He was assigned responsibility for all advanced NASA programs. He was responsible for developing the Galaxy, Leasat and JCSat systems, leading the development of the multispectral scanner for Landsat, and initiating the direct broadcast satellite and mobile satellite programs. Under his direction the Pioneer Venus program landed four probes on the Venusian surface and put a scientific satellite into orbit around Venus. He shares in two patents and received the Distinguished Public Service Medal, NASA's highest award, for his work on Pioneer Venus. Dorfman received his B.S. in electrical engineering from the University of Florida and an M.S. in electrical engineering from the University of Southern California.

David T. Edwards is the executive vice president and chief operating officer of Earth Observation Satellite Co. (EOSAT). He is responsible for all EOSAT domestic and international operations, including marketing, satellite mission management, and follow-on satellite development. Before joining EOSAT he served as director of Financial Planning and Decision Support Systems at Hughes Aircraft Corporate Headquarters in Los Angeles, Calif. He also held the position of Chief Financial Officer at the Santa Barbara Research Center, a subsidiary of Hughes Aircraft where he developed the initial business plans in support of Landsat commercialization. Before joining Hughes Aircraft, he worked six years at Grumman Aerospace where he performed a number of duties in program business management and corporate planning. He earned both his B.A. and M.S. in finance and accounting from Adelphi University in Garden City, NY.

Dr. Murray Felsher is president of Associated Technical Consultants (ATC) and director of North American Remote Sensing Industries Association. He began his career in remote sensing as a graduate research and teaching assistant in photogeology at the University of Massachusetts in Amherst in 1959 while pursuing a master's degree. He joined the Geology Department faculty at Syracuse University before moving to Washington D.C. to become associate director of a National Science Foundation-funded program at the American Geological Institute. With the formation of the U.S. Environmental Protection Agency, he joined the EPA as a senior staff geologist. He transferred to NASA where he served in various capacities including the originator and first program manager of NASA's Regional Remote Sensing Applications Program. He left in 1980 to form ATC whose clients have included the FBI, Orbital Sciences Corporation, and the Eastman Kodak Company where he was hired in a permanent consulting capacity as director of Special Projects. As a consultant to the Department of Defense's Landsat Program Office he was responsible for establishing a civilian "gateway" to DOD's Landsat-7 imagery. He is the publisher of Washington Remote Sensing Letter, the oldest and largest subscription newsletter devoted to remote sensing/GIS. He is a Fellow of the Geological Society of America and a senior member of the American Astronautical Society.

Theresa Foley is a freelance writer who specializes in space issues. She has 15 years experience covering space programs and issues, including five years as the editor of the weekly newspaper *Space News* and more than three years as the space technology editor of *Aviation Week* and *Space Technology* magazines. She has written hundreds of articles about satellite communications, launchers, military space programs and NASA, travelling to Europe, South America and around the United States in the process of reporting on these programs. She holds a bachelor's degree in journalism from University of South Florida.

Dr. Brenda Forman is the corporate director of international marketing policy for Lockheed Corp. She is also a nationally-known, widely published author and commentator on U.S. and international technology policy, space policy, and trade policy. She developed a course which deals with the interaction between the political process and the engineering design process which she teaches at the University of Southern California's Graduate School of Engineering. She went to Lockheed in October 1983 after five years in the Department of Commerce, where she was the director of the division of Policy Planning in the office of Export Administration. During her last year at the Department of Commerce, she served as senior technology policy advisor under the assistant secretary of commerce for trade development. She earned her Ph.D. in political science from the City University of New York. She has received the Department of Defense Distinguished Civilian Service Award.

Professor Joanne I. Gabrynowicz, J.D., is the director of Graduate Studies and a professor of Space Law and Policy at the University of North Dakota which is the only university in the world to offer a master of science in space studies. Before going to the university she practiced law in New York City for seven years. She writes and speaks regularly on space and remote sensing law and has published a number of papers on the subject. She has presented her work to the International Institute of Space Law, of which she is a member; to the Federal Bar Association; the Association of American Law Schools; the Space Studies Institute; and the Lunar and Planetary Institute; among others. She is currently a member of the Congress of the United States Office of Technology Assessment Earth Observations Advisory Panel; the International Academy of Astronautics Subcommittee on Return to the Moon and the Committee on International Space Plans and Policies. She received her juris doctor degree from the Benjamin N. Cardozo School of Law of Yeshiva University and her bachelor of arts in history and literature from Hunter College of the City University of New York.

Lt. Gen. Jay M. Garner, USA, is the commander of the U.S. Army Space and Strategic Defense Command headquartered in Arlington, Va. He began his military service in the Florida National Guard. He then enlisted as a Marine and was commissioned a second lieutenant in the Army. His military career has included assignments in Kentucky, Texas, Europe, northern Iraq, Frankfurt, Germany, and Vietnam. Before his current assignment he served as assistant deputy chief of staff for Force Development, ODCSOPS, Washington, D.C. He has attended the U.S. Army War College, the U.S. Marine corps Command and General Staff College, the U.S.Army Air Defense Artillery Advanced and Basic Officer Courses, and numerous other military schools. He holds a bachelor's degree in history from Florida State University. His awards include the Distinguished Service Medal., the Defense Superior Service Medal, the Legion of Merit with four oak leaf clusters and the Bronze Star.

Lt. Col. Charles D. (Sam) Gemar, USA was selected as an astronaut in 1985. A 1979 graduate of the United States Military Academy at West Point, he attended Infantry Officers Training Course, Initial Entry Rotary Wing Aviation Course and the Fixed Multi-Wing Aviator's Course at Ft. Rucker, Ala. In 1980, he began assignment at Stewart/Hunter Army Airfield as an assistant flight operations officer and flight platoon leader. He also completed the Army Parachutist School and the Aviation Officers Advanced Course. Gemar's first shuttle flight was as a mission specialist on STS-38, a Department of Defense mission about Atlantis in November 1990. He next flew as a mission specialist on STS-48 aboard Discovery that deployed the Upper Atmosphere Research Satellite in September 1991. He most recently served as a mission specialist on the crew of STS-62, a 14-day extended duration Orbiter mission in March 1994. Gemar has logged more than 581 hours in space.

Dr. Moira Gunn is the producer and host of *Tech Nation...Americans & Technology* and an adjunct professor at the University of San Francisco. A former NASA engineer and scientist, she is an engineering consultant, specializing in engineering management, technology audits, systems testing and robotics systems. Her robotics systems are in operation today at such diverse sites as IBM Corporation, Lockheed Missiles & Space, Morton Thiokol, and the U.S. Navy. She holds a patent, along with USDA nutrition scientists, on a computerized food intake measurement system. While at NASA's Institute for Advanced Computation, she managed the software development of large scientific applications including; global weather and climate models, satellite image processing, earthquake modeling and prediction, and real-time satellite tracking on supercomputers. She holds a Ph.D. in mechanical engineering and a master of science in computer science from Purdue University.

Jeffrey K. Harris is assistant secretary of the Air Force for Space and director of the National Reconnaissance Office. He is responsible for overall supervision of Air Force space matters, with primary emphasis on policy, strategy, and planning. He began his career with the Central Intelligence Agency providing technical support to a diverse group of intelligence users. He then joined the Office of Development and Engineering's satellite development programs. He served as chief of System Analysis and associate director for several system acquisitions which included U.S. space- based reconnaissance and intelligence systems. During this period, he also managed research and development for space technologies; identifying emerging technologies for application to the space reconnaissance and ground processing functions. Before assuming his current position in May 1994 he was associate executive director for Intelligence Community Affairs. He graduated from Rochester Institute of Technology with a B.S. in photographic science and instrumentation.

Douglas A. Heydon is president of Arianespace, Inc., the U.S. subsidiary of Arianespace, responsible for marketing and sales in the U.S. of Ariane launch services. Before his promotion he served as executive vice president and general manager of Arianespace. Prior to this he was director of marketing for Space Programs at the Convair division of General Dynamics for three years. Early in his career, he held a wide variety of engineering and management positions with Sperry Gyroscope Company, TRW Systems and its predecessor Space Technology Laboratories, and Transco Products. Also, he cofounded and operated Filter Technology, Inc., a small quartz crystal filter company based in Carlsbad, Calif. and has served as an electronic technician in the U.S. Navy and as a research and development officer in the USAF Reserve. He received his bachelor of aeronautical engineering from Rensselaer Polytechnic Institute and his master of science in aeronautical engineering from Stanford University.

Lionel "Skip" Johns is the associate director for technology in the Office of Science and Technology within the Executive Office of the President. Johns is responsible for technology research and development policy coordination between Federal Agencies. These responsibilities, coordinated through the National Science and Technology Council, include space and aeronautics, industrial R&D, defense conversion, information and communications and education and training technologies. After receiving a B.S. from the University of Virginia, he served in the U.S. Navy as a carrier-based naval aviator. Prior to joining OSTP, Johns served as assistant director of the Office of Technology Assessment and was responsible for the analysis of industrial competitiveness, quality of the work force, energy, materials, national security, space, and international technology transfer and trade. He is a member of the Council on Foreign Relations and serves on the Critical Technologies Subcouncil of the Competitiveness Policy Council. Johns has 16 years of management experience in high technology industries such as: Ocean Science and Engineering Inc., Hazeltine Corp., the Magnavox Co., and General Instrument Corp. He also spent several years in corporate finance at Alex Brown & Sons. He was elected a Fellow of the American Association for the Advancement of Science.

Dr. Francis X. "Duke" Kane is the president of the GPS International Association and participates in government committees concerned with civil users and GPS technology including consulting for the Office of the Secretary of Defense on development of long range strategy and policy. He has served as director of strategic systems, Advanced Systems Development, for Rockwell International; manager of requirements analysis for TRW Systems Inc., which included performing studies of national security policy and strategy and application of technologies to emerging business opportunities; deputy for development plans for Air Force Space and Missile Systems Organizations; and special assistant to the deputy chief of staff of research and development in the Office of the Secretary of the Air Force. He initiated and conducted internal analyses of the impact of SALT and SALT II on Minuteman and MX missiles and provided the data to OSD and the Air Force. He holds a bachelor of science from the U.S. Military Academy, West Point, NY; a master's and a Ph.D. from Georgetown University. He is a Fellow of the American Institute of Aeronautics and Astronautics and of the International Academy of Astronautics and its Space Safety and Rescue Committee.

Dr. Marshall H. Kaplan is director of civil and commercial space activities at Veda Incorporated with headquarters in Alexandria, Va. Before joining Veda, Kaplan was an independent consultant providing technology, training, and management support to industry, universities, and governments. He is writing his fourth book, "Obtaining Research Funding for Engineering and Science Projects" which demonstrates his reputation as an expert in spacecraft and launch vehicle design, as a lecturer in space technology, and as a leader in developing large systems and research and development proposals for U.S. Government contracts and grants. He has served as associate vice president for research and executive director of Space Research Institute at the Florida Institute of Technology where he was also a professor of aerospace engineering. He received his bachelor of science in aeronautical engineering from Wayne State University, his master's degree in aeronautics and astronautics from Massachusetts Institute of Technology and a Ph.D. in the same field from Stanford University. He is affiliated with several professional organizations including the American Institute of Aeronautics and Astronautics (AIAA), the American Astronautical Society, and the AIAA Technical Committee on Space Transportation. He is a pilot with over 3,400 hours of flight experience.

Lt. Gen. Jay W. Kelley, USAF, is the commander of Air University, Maxwell AFB, Ala. and director of education, Air Education and Training Command. Gen. Kelley entered the Air Force Reserve in 1959 and was selected to attend the USAF Academy in 1960. He was commissioned in June 1964 and has served in Texas, Arizona, Nebraska, Alabama, Washington D.C., London, Missouri, Kansas, and Colorado. He holds a master of science degree in political science from Auburn University, Ala. He has served as a base commander and a strategic missile wing commander, was assigned to the Organization of the Joint Chiefs of Staff, was vice commander of Air Force Space Command and director of public affairs, Office of the Secretary of the Air Force. Kelley has been in his present position since October 1992. His military decorations include the Distinguished Service Medal, Defense Superior Service Medal, Legion of Merit, Defense Meritorious Service Medal, Meritorious Service Medal with oak leaf cluster, Joint Service Commendation Medal, and the Combat Readiness Medal.

Gil I. Klinger was named acting deputy under secretary for Space in the office of the Under Secretary of Defense for Acquisition and Technology in February, 1995. He previously served as director, Space and Advanced Technology Strategy and director, Strategic Forces Policy in the Office of the Assistant Secretary of Defense for International Security Policy. Klinger also served as a presidential management intern from 1985-1987. A consultant in political science at the Rand Corporation, he also worked as an analyst for Trident II(D-5) Missile Program for the Navy Strategic Systems Project Office and as a senior research assistant at the Carnegie Endowment for International Peace. He has received several honors from the Department of Defense including the Secretary of Defense Medal for Meritorious Civilian Service. He holds a bachelor of arts degree, summa cum laude, in political science and European history from the State University of New York at Albany and a master's in public policy from the John F. Kennedy School of Government at Harvard University.

Dr. John M. Logsdon is a professor of Political Science and International Affairs and director of both the Center for International Science and Technology Policy and the Space Policy Institute of Elliott School of International Affairs at George Washington University, where he has been since 1970. He is also a faculty member of the International Space University. He received his bachelor of science in physics from Xavier University and a Ph.D. in political science from New York University. He is a trustee of the International Academy of Astronautics, a member of the Board of Advisors of The Planetary Society and the National Space Society, and a member of the Aeronautics and Space Engineering Board of the National Research Council. He is a Fellow of the American Association for the Advancement of Science and an Associate Fellow of the American Institute of Aeronautics and Astronautics. He is the North American editor for the journal *Space Policy*.

Dr. John E. Mansfield was named associate administrator for Space Access and Technology at NASA Headquarters, Washington D.C. in September 1994. He oversees a wide range of development activities relating to future space technologies and future space launch systems in accordance with the priorities established by the Administration's National Space Transportation Policy. Before joining NASA, he served as a professional staff member on the Senate Armed Services Committee where he was responsible for preparing scientific, technical, budgetary, and policy recommendations for the minority members of the Subcommittee on Strategic Forces and Nuclear Deterrence. He has previously held positions including chief scientist, in the Defense Advanced Research Projects Agency; served as a professional staff member on the House Armed Services Committee; and held key management positions in the Defense Nuclear Agency and Defense Intelligence Agency. He earned undergraduate and graduate degrees in classical languages, mathematics, philosophy and physics and holds a Ph.D. in Theoretical Physics from Harvard University.

Dr. Hans Mark is a professor in the Department of Aerospace Engineering and Engineering Mechanics at the University of Texas at Austin. He was the chancellor of the UT system from 1984 to 1992. Prior to that he taught at the University of California at Berkeley and at Stanford University. From 1981 to 1984 he served as deputy administrator of NASA and was also named Secretary of the Air Force by President Jimmy Carter. Before moving to Washington D.C., he was director of the NASA-Ames Research Center at Moffett Field, Calif., where he coordinated and carried out research in areas ranging from fundamental aerodynamics, to spacecraft development, to the human factors that affect space flight. He obtained a bachelor of arts degree in physics from UC-Berkeley and a Ph.D. in physics from Massachusetts Institute of Technology. He also holds honorary doctorates in science from Florida Institute of Technology and in engineering from Polytechnic Institute of New York. He is the author and co-author of more than 150 scholarly articles and numerous books. He has been awarded the NASA Distinguished Service Medal, twice; the USAF Decoration for Exceptional Civilian Service; and the Department of Defense Distinguished Public Service Medal. He is a fellow of the American Physical Society, the American Institute of Aeronautics and Astronautics and the American Association for the Advancement of Science.

John Morgan is the director general of the European Organisation for Meteorological Satellites (EUMETSAT) in Darmstadt, Federal Republic of Germany. He was elected the first director after serving as the chairman of the technical working group who set up EUMETSAT. The early part of his career was devoted to operational meteorology, in many forecast offices within the UK as well as substantial periods in North Africa and in what is now known as Yemen. After the forecasting phase of his career ended he joined the super-computer systems teams at the headquarters of the UK Meteorological Office in Bracknell, England. There he learned programming skills and first began to take an interest in the stand-alone computer systems which later became the ubiquitous personal computer. He became the Meteorological Operations Manager for Meteosat in the European Space Operations Centre of the European Space Agency from 1977 to 1982. He then returned to the UK to take charge of the Satellite Meteorology branch of the UK Meteorological Office and to prepare for the establishment of a European organisation which could take long-term responsibility for Meteosat. As director of EUMETSAT he has participated in the successful launch of Meteosats 3, 4, 5, and 6.

Theodore G. Nanz became president of SPOT Image Corporation in 1990. SPOT is a major provider of satellite imagery to the Department of Defense; the imagery was widely used during the Gulf War. Before joining SPOT Image, he served as President to Dynatech Communications, a data communications company; president and chief executive officer of Coherent Communications Systems, a networking and satellite communications company, in New York; and vice president and general manager of Mitel, a telecommunications company in Florida. He also spent ten years with Motorola, in the U.S. and in Malaysia; and worked as an engineer at Systems Engineering Laboratories in Florida. He has a bachelor of science in electrical engineering from the U.S. Naval Academy, Annapolis, Md.; an M.B.A. from Florida Atlantic University, Boca Raton, Fla.; is a certified quality engineer; and a graduate of the Phil Crosby Quality College. While in the Navy he served as a guided missile officer, an anti-submarine warfare officer and navigator on guided missile cruisers and destroyers during two Vietnam deployments, as well as Mediterranean and North Atlantic deployments.

Dr. Peter G. Neumann is principal scientist in the Computer Science Laboratory at SRI International where he has been concerned with computer system requirements for security, reliability, human safety, and high assurance. He is a fellow of the Association for Computing Machinery and the Institute of Electrical Engineers. He also is a member of the Computer Society. Neumann has served as an elected member-at-large of the Section Committee for the American Association for the Advancement of Science. He also was the founder and editor of the SIGSOFT Software Engineering Notes and currently is the associate editor for the RISKS material. He is coauthor (with Oscar Firshein et al.) of the book, "Artificial Intelligence for Space Station Automation: Crew Safety, Productivity, Autonomy, Augmented Capability." He also has served on an expert panel for the U.S. House and Judiciary Committee Subcommittee on Civil and Constitutional Rights. Neumann received his AB, SM, and PhD degrees from Harvard in 1954, 1955, 1961, respectively. In 1960 he received the Dr. rerum naturarum degree from the Technische Hochschule, Darmstadt, Germany, where he was a Fulbright scholar for two years. He has worked in the computer field since 1953.

James P. Noblitt is vice president and general manager for the Boeing Defense and Space Group, Missiles and Space Division. He is responsible for Boeing's work as prime contractor on NASA's International Space Station program. During the Apollo program, he worked on the integration team for the giant Saturn V rockets which took American astronauts to the Moon. After a stint designing commercial jetliners, he was put in charge of preliminary design activities for air-launched cruise missiles. He directed the design and proposal efforts on advanced versions of the Short Range Attack Missile and the Air Launched Cruise Missile. In 1989 he was named vice president for Space Systems, then vice president and assistant general manager of Missiles and Space Division in 1992 and general manager in 1993. He is an aeronautical engineering graduate of Purdue University and an active member of national organizations including the American Institute of Aeronautics and Astronautics and the National Space Society.

John W. O'Neill is the director of the Johnson Space Center Mission Operations Directorate which provides the preflight planning, training, and real-time flight control for NASA human space flight operations and the supporting transportation elements. His 30 years with NASA include systems operations and procedures development for the Gemini Program, and management of the flight planning and onboard data processes for the Apollo and Skylab programs. He was a project engineer with Sandia Laboratory in Albuquerque, N.M., and served as a fighter interceptor pilot in the USAF Air Defense Command before joining NASA. He received a B.S. in mechanical engineering from the University of Nebraska and a master of science in mechanical engineering from the University of New Mexico. His honors include; the NASA Exceptional Service Medal, twice; the Presidential Medal of Freedom; and NASA Engineer of the Year in 1989. He is a member of the National Society of Professional Engineers, American Institute of Aeronautics and Astronautics, American Society of Mechanical Engineers, and the National Management Association.

Jaime Oaxaca is the vice chairman of Coronado Communications Corporation, Los Angeles, Calif., in charge of public relations, marketing, and research. He has 37 years of experience in the fields of engineering, engineering management, and program management. He held various administrative positions including director of international and domestic marketing and long range planning; vice president of missile programs and vice president and assistant general manager of the Northrop Corporation, Electro-Mechanical Division; and president of Northrop-Wilcox Electric, Inc. He holds a bachelor of science in electrical engineering from the University of

Texas, El Paso, and is a graduate of the School of Business at Stanford University. He is a Distinguished Fellow of the Institute for the Advancement of Engineering. He was the first recipient of the "Jaime Oaxaca" award for excellence in engineering and dedication to the community from the Society of Hispanic Professional Engineers, the Business and Industry Award from the Mexican-American Opportunities Foundation, and the Outstanding Engineer Merit Award from the Institute for the Advancement of Engineering.

David L. Payne is currently the Spacecraft Technology Line of Business manager for TRW's Space and Technology Division. His responsibilities include new business acquisition and marketing; spacecraft technology development and administration; and strategic planning for division business lines. Prior to his current assignment, he was the manager of commercial products responsible for developing non-traditional markets for the division's spacecraft technologies. He was also the product line manager for Brilliant Pebbles/SDIO intergroup activities. His responsibilities included fact finding from Pentagon agency representatives, legislative contacts with delegations and representatives from the House and Senate, and interface with key national laboratories and aerospace contractors. He was TRW's representative to Air Force Space Command during Operation Desert Storm supporting the chief scientist in optimizing DSP warning to civilian and military authorities. He received a bachelor of science in systems engineering and economics from University of California at Los Angeles.

Lon Rains has been editor of *Space News* since November 1993. He joined Space News in October 1989 as the Advanced Technology and Soviet Space Program reporter. He was responsible for covering the former Soviet Union's military and civilian space programs and a number of civil and military space programs in the United States, including the National Aerospace Plane program and the work of research labs of NASA, the Department of Energy, and the Department of Defense. He was promoted to senior editor in January 1991. His responsibilities included supervising the editing staff, the freelance writers, the use of graphic arts and the production of the newspaper. He has worked as a journalist since 1982 for *Prince George's Journal*, a daily newspaper in the Washington, D.C. suburbs, the *Washington Post*, the *Baltimore Evening Sun* and he has written for *Discover* magazine. He received a bachelor's degree in political science from the University of Maryland. He has won reporting awards for spot news and public service journalism.

Bernard P. Randolph is vice president and special assistant to the executive vice president and general manager TRW Space & Electronics Group. He joined TRW after 35 years of distinguished service in the Air Force, retiring with the rank of general. His final USAF assignment was as commander of the Air Force Systems command. He holds a B.S., M.S. and an honorary doctorate in electrical engineering from the University of North Dakota and an M.B.A. from Auburn University. He is a member of the Defense Science Board of the Department of Defense; Defense Intelligence Agency Scientific Advisory Board; consultant for the Institute for Defense Analyses; and a member of the Advisory board for Lincoln Laboratory at the Massachusetts Institute of Technology. His military decorations include the Distinguished Service Medal, Legion of Merit with one oak leaf cluster, Bronze Star Medal and the Meritorious Service Medal.

Thomas F. Rogers is the president of the Space Transportation Association which is interested in using space more by expanding and increasing efficiency in space transportation. He is also a physicist, a communications engineer, a private investor, and the president of his family's private operating foundation, the Sophron Foundation which is emphasizing low-earth-orbit life sciences and biomedical research. His experience in research and development is extensive and has included serving as deputy director of Defense Research and Engineering in the Office of the Secretary of Defense where he was responsible for research and development supporting the command and control of our nuclear strike forces. Rogers did research and development work during World War II at the Radio Research Laboratory of Harvard University and, later, at the Bell and Howell Company and the Air Force Cambridge Research Center. He has held senior federal government positions, and professional positions with university, industrial, and non-profit organizations. He was a member of the National Academy of Sciences/Institute of Medicine/Robert Wood Johnson Foundation group that created early emergency medical systems including the 911 emergency number in over forty locations across the U.S. Rogers holds a bachelor of science from Providence College and a master's degree in physics from Boston University and is a Fellow of the Institute of Electrical and Electronics Engineers.

Gen. Bernard A. Schriever, USAF (Ret.), retired from the Air Force in 1966 as a four-star general after more than 33 years of service. He was the first commander of the USAF Systems Command which was responsible for all Air Force research, development, testing, and acquisition of all USAF weapons systems. Since retiring he has served in many advisory roles for the U.S. government including chairman of the President's Advisory Council on Management Improvement and member of the President's Foreign Intelligence Advisory Board. He now serves on the Ballistic Missile Defense Organization Advisory Committee. After retirement he became an industry management consultant and served on a number of boards including Control Data, Eastern Airlines, American Medical International and The Aerospace Corporation. He has a B.S. from Texas A&M and while in the Air Force he received an M.S. in aeronautical engineering from Stanford. He has received seven honorary doctorate degrees. He was inducted into the Aviation Hall of Fame in 1980 and is an Honorary Fellow in the American Institute of Aeronautics and Astronautics.

Dr. Ronald M. Sega was selected as an astronaut in 1991. A graduate of the USAF Academy, Sega completed Air Force pilot training in 1974 and served as an instructor pilot in the Air Force from 1976-1979. He served on the faculty of the Air Force Academy's Department of Physics from 1979-82 and then joined the faculty of the University of Colorado in Colorado Springs. While on leave from CU-CS, he served as research associate professor of physics at the University of Houston and was a co-principal investigator of the Wake Shield Facility. Sega was a mission specialist on STS-60, the first joint U.S./Russian Space Shuttle Mission. Launched in February, 1994, STS-60 was the second flight of the Space Habitation Module-2 (SpaceHab-2), and the first flight of the Wake Shield Facility. he was the flight engineer for ascent and entry on this mission, performed several experiments on orbit and operated the robotic arm, berthing the Wake Shield onto its payload bay carrier on four separate occasions. Sega has logged 199 hours in space. He received a bachelor's degree in mathematics and physics from the Air Force Academy; a master's in physics from Ohio State, and a Ph.D. in electrical engineering from the University of Colorado.

Gregory C. Simon is the chief domestic policy advisor to Vice President Al Gore. He represents the Vice President in such policymaking bodies as the National Economic Council, the Domestic Policy Council, the Office of Science and Technology Policy, and numerous interagency task forces. He joined Vice President Gore's staff as legislative director in 1991, when the Vice President was in the Senate and served as issues director for the Vice President during the 1992 presidential campaign. Before joining Gore's Senate staff, he served as staff director of the Subcommittee on Investigations and Oversight of the House of Representatives, Science, Space and Technology Committee, which he joined as counsel in 1985. During his years with the Science Committee, he organized a series of investigatory hearings related to NASA, scientific misconduct, neurotoxins, the use of human biological materials in research and the artificial heart program. Simon holds a bachelor of arts degree in history from the University of Arkansas and received his law degree from the University of Washington and is a member of the Washington State bar.

Dr. Vernon Singhroy is a senior research scientist at the Canada Centre for Remote Sensing, Ottawa, Canada. He received his Ph.D. in environmental and resource engineering at the State University of New York at Syracuse. He is editor-in-chief of the *Canadian Journal of Remote Sensing.* He has published extensively on the use of remote sensing in resource management in areas within and outside Canada. He has conducted remote sensing projects in Guyana, Brazil, Jordan, and the Caribbean Basin. He also advises Canadian foreign aid and international research agencies on projects related to the utility of remote sensing in developing countries.

Courtney A. Stadd is managing partner of Global Technology Ventures, a Maryland- based company providing investment, business, and market planning support to a broad range of technology clients. He has held several high-level federal government positions including senior director for Commercial Space Policy, the White House National Space Council; director of the Office of Commercial Space Transportation, U.S. Department of Transportation; and special assistant for Space Commerce, Office of the Secretary, U.S. Department of Commerce. He also held the positions of special assistant to the NASA administrator and NASA acting deputy associate administrator, Office of Advanced Concepts and Technology. He has received several awards from industry associations for his contributions to public policy as it affects space commercialization, including the 1994 Lloyd V. Berkner Award from the American Astronautical Society, and two separate awards from the Washington Space Business Roundtable.

Dr. Edward C. Stone is director of the Jet Propulsion Laboratory, vice president and David Morrisroe professor of physics at the California Institute of Technology. He served as chairman, vice chairman, and currently chairman of the Board of Directors of the California Association for Research in Astronomy, which builds and operates the two W. M. Keck Observatory ten-meter telescopes on Mauna Kea, Hawaii. He earned an A.A. from Burlington Junior College and a M.S. and Ph.D. in physics from University of Chicago. His awards include the NASA Exceptional Scientific Achievement Medal; the NASA Distinguished Service Medal, the American Institute of Aeronautics and Astronautics Dryden Medal and Space Science Award, and the NASA Distinguished Public Service Medal. He is a Fellow of the American Physical Society, the American Geophysical Union, and the American Institute of Aeronautics and Astronautics.

Dr. Peter A. Swan is the manager of business development for Motorola Satellite Communications Division. He has been a professor of space operations at Capitol College; has taught astronautics, engineering systems design, and management system acquisition at the Air Force Academy; and was a technical representative of Motorola's Satellite Communication, Inc. He holds a B.S. in engineering from the United States Military Academy; a M.S. in nuclear engineering from the Air Force Institute of Technology; an M.S. in systems management, research and development, from the University of Southern California; and a Ph.D. in engineering, dynamics and control, from the University of California at Los Angeles. He is a Fellow of the British Interplanetary Society and an associate Fellow of the American Institute of Aeronautics and Astronautics.

Brigadier General Burt S. Tackaberry, USA, is the assistant division commander for support, 82nd Airborne Division, Fort Bragg, N.C. He was commissioned in the infantry upon graduation from Officers Candidate School. He holds a bachelor of science in political science from the University of South Florida and a master of science in business administration from Webster University. His military career has included assignments in Georgia, Vietnam, Alabama, Europe, Kansas, Kentucky, Saudi Arabia, and Korea. He has served as a military faculty member at the Air War College, Maxwell AFB, Ala. and command director, North American Aerospace Defense Command Center, Peterson AFB, Colo. His decorations include; the Legion of Merit with Oak Leaf Cluster, the Bronze Star Medal with three "V" Devices, Bronze Star Medal with two oak leaf clusters and the Meritorious Service Medal with two oak leaf clusters.

Frank C. Weaver is the director of the Office of Commercial Space Transportation, serving the Secretary of Transportation. As an internationally published author and lecturer, he is regarded as an expert in the space industry. Before his appointment to the Department of Transportation he was president of UNET Communications, providing marketing, strategic planning, and systems engineering of a wide variety of satellites and launch vehicle systems to the international space industry. He was also an entrepreneur and small business marketing consultant. He received his bachelor of science in electrical engineering from Howard University and aM.B.A. in marketing from University of North Carolina in Chapel Hill. He received an honorary doctor of science from Saint Augustine's College in Raleigh, North Carolina. He is a senior fellow of the American Institute of Aeronautics and Astronautics, a member of the National Space Club, and served as secretary of the Washington Space Business Roundtable.

Robert S. Winokur was named Assistant Administrator for Satellite and Information Services at the National Oceanic and Atmospheric Administration in November 1993. He had served as technical director in the Office of the Oceanographer of the Navy and Office of the Chief of Naval Operations. Winokur has served in various senior management and technical positions over the past 30 years including: branch head and division director, Naval Oceanographic Office. His experience includes underwater acoustics, ocean policy, undersea warfare, satellite and manned space oceanography, information technology and national environmental issues. He has a B.S. from Rensselaer Polytechnic Institute and a M.S. from The American University. He is vice president for technical affairs for the Marine Technology Society and is a fellow of the Acoustical Society of America.

Joseph P. Zimonis is vice president of Pratt & Whitney's space propulsion operations. He manages USBI Co., a NASA prime contractor for the space shuttle solid rocket booster refurbishment, and Pratt & Whitney's liquid space propulsion programs. He has been with Pratt & Whitney for 36 years and has held various engineering and program management positions in operations located in Connecticut, Florida, and Alabama. He holds a B.S. in chemical engineering from Worcester Polytechnic Institute and a B.S. in mechanical engineering from Rensselaer Polytechnic Institute.

SPACE TECHNOLOGY HALL OF FAME

SPACE SPINOFFS are materials and products originally developed for space program application and which have made significant contributions to benefit all people. Spinoffs are nominated each year for induction into the Space Technology Hall of Fame.

Sponsored by NASA since 1988, the Space Technology Hall of Fame honors individuals and companies responsible for these remarkable products. Though the number of inductees is limited, each nominee is truly a winner in its innovation and practical, valuable benefit to humankind.

ANTI-CORROSION COATINGS

Anti-corrosion coatings were developed in the 1970s to protect gantries and other launch-related structures at NASA's Kennedy Space Center from the corrosive effects of ocean spray and fog. In 1981, NASA granted a license to Shane Associates for the rights to the anti-corrosion material. Inorganic Coatings, Inc. signed an agreement with Shane to become the sole manufacturer and sales agent for the product. The commercial version is a non-toxic, water-based material that bonds well to steel and dries within 30 minutes to a ceramic-like, hard, durable finish. Anti-corrosion coatings have been used to protect bridge girders, pipelines, oil rigs, military tanks, dock equipment, buoys, municipal water facilities, antennas and tractor-trailer frames. In its most publicized use, commercial anti-corrosion coating was used to protect the wrought-iron interior of the Statue of Liberty during its refurbishing.

PARAWINGS OR HANG GLIDERS

Parawings or hang gliders were developed in 1948 for use as a wing on inexpensive aircraft. In 1958, NASA considered the parawing as a means of returning space payloads to Earth. While NASA did not select the parawing, the military became interested in it for parachuting. In the mid-1960s Pioneer Aerospace and Irvin Industries, parachute manufacturers, built parawings for the Army's Golden Knights precision parachute team. This initial use of the parawing gave birth to the now $50-million annual hang gliding industry. Today, dozens of companies around the world produce parawings, hang gliders and powered gliders for military, commercial and recreational uses.

ANTI-CORROSION COATINGS
Developed through the cooperative efforts of:

NASA Goddard Space Flight Center
Shane Associates
Inorganic Coatings, Inc.
Scott Armstrong
Christine Childers
Parke Schaffer, Jr.
John B. Schutt, Ph.D.

PARAWINGS or HANG GLIDERS
Developed through the cooperative efforts of:

NASA Langley Research Center
Pioneer Aviation Corporation
Irvin Industries
Moyes California, Inc.
Wills Wing, Inc.
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SPACE TECHNOLOGY HALL OF FAME

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SPACE TECHNOLOGY HALL OF FAME

THE OTHER 1995 NOMINEES

Aircraft Design Software is a software program tool designed to improve the conceptual aircraft design process. This software has enabled the major aircraft companies to become more competitive by making the design process less costly while producing more effective aircraft designs.

Bioreactor for Cell Culture Systems was created to study the effects of cell interaction, metabolism and other cellular functions in microgravity and to protect cultures from high shear forces present during space shuttle launch and landing. The commercial bioreactor design reduces the effects of shear and gravity while in an earth-gravity environment, allowing for the growth of such things as cancer tumors outside the human body and their subsequent study — a vital step in the search for cancer cures.

Construction Specification System. Devised in the '60s when NASA embarked on a massive construction program, the PC-version of this computerized, comprehensive catalog of master-building specifications today supports government agencies and many architectural firms.

Fire Resistant Aircraft Seats were developed in the aftermath of the 1967 Apollo 1 fire and have been used in all U.S. spacecraft since. These seats are found on virtually all commercial aircraft in use in the U.S. today and save an estimated 20 to 25 lives each year.

Image-based Information System. Developed to process mapping data from space for use in producing map and image data for analysis and presentation, image-based information is used by government for resource inventory, by businesses to perform market area analysis and for city planning, building and land use management.

Low-Vision Enhancement System. This system captures minute information by satellite camera, zooming in on an image and enhancing it with computer software. It aids the vision of over three million visually impaired Americans who cannot readily discern low-contrast or who experience blind spots, tunnel vision or suffer from macular degeneration.

Magnetic Liquids (Ferrofluids) do not exist in nature. They are used in such industrial processes as fusion research, the development and manufacturing of analytical instrumentation, visual displays, medical equipment and automated machine tools.

Ocular Screening System, a digital-imaging process designed to interpret Landsat satellite observations of Earth, is also used to examine the human eye by photographically recording its reflective properties. This data helps determine the quality of the eye.

Robotic Ultrahigh-Pressure Waterjet Stripping is a robotic-precision-controlled, high-speed waterjet cleaning system for the space shuttle external tank. It is used for several industrial cleaning applications such as paint removal from aircraft, railroad cars, tank farms and shipyards.

Underwater Location Aid (The "Pinger") is a system that precisely locates submerged space objects (space payloads, spacecraft booster, etc.). It is now used by airlines and others to assist in locating craft in the event of an accident.

1995 11th National Space Symposium Volunteers

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Larry Aragon
Speaker Ready Room

Rick Hargrave
Media Room

Les Hayden
Transportation

Jerry Lemberger
Security

Sheila Lemberger
Transportation

Steve Lootens
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Abbreviations & Acronyms Glossary

ABM	Anti-Ballistic Missile
ACRV	Aerospace Crew Rescue Vehicle
AEGIS	Airborne Early Warning Ground Integration System
AFSOC	Armed Forces Special Ops Com.
AFSPACECOM	Air Force Space Command
ALERT	Acute Launch Emergency Reliability Tip
ALS	Advanced Launch System
AOR	Area of Responsibility
APM	Antenna Positioner Mechanism/-Attached Pressurized Module
ARPA	Advanced Research Projects Agency
ARSPACE	US Army Space Command
ASAT	Anti-Satellite Weapon
ASPO	Army Space Program Office
ASTRO	Army Space Tech.& Research Office
ATO	Abort to Orbit Air Tasking Order
ATP	Advanced Technology Program
AVHRR	Advanced Very High Resolution Radiometer
BDA	Battle Damage Assessment
BLADES	Military accounting systems being replaced by JONAS
BMC3	Battle Management Command, Control, and Communication
BMDO	Ballistic Missile Defense Org.
C3	Command, Control, and Comm.
CBO	Congressional Budget Office
CENTCOM	US Central Command
CEOS	Committee on Earth Observing Satellites
CINC	Commander in Chief
CINCSAC	Comm. in Chief Strategic Air Com.
CINCSPACE	Comm. in Chief US Space Com.
CNES	Centre National Détudes Spactiales (The French space agency)
CNO	Chief of Naval Operations
COMM	Communications
COMSAT	Communications Satellite
COMSTAC	Commercial Space Transportation Advisory Committee
CTAPS	Contingency Tactical Air Control Planning System
DARO	Defense Airborne Recon. Office
DARPA	Deutsche Agentur Für Raumfahr-tangelegen-Heiten (German Space Agency)
DARPA	Defense Advanced Research Project Agency
DBS	Direct Broadcast Satellite
DMA	Defense Mapping Agency
DMSP	Def. Meteorological Satellite Prog.
DoD	Department of Defense
DoE	Department of Energy
DoT	Department of Transportation
DSCS	Defense Satellite Comm. System
DSP	Defense Support Program
EHF	Extremely High Frequency
EIS	Environmental Impact Statement
EIRP	Elect. Integrated Receiver Prog.
ELV	Expendable Launch Vehicle
EOS	Earth Observing Satellite System
EOSDIS	Earth Observing Satellite Distribution System
EPS	EUMETSAT Polar Systems
ERS	Earth Resource Satellite
ESA	European Space Agency
ETF	Environmental Task Force
EUCOM	US-European Command
EUMETSAT	European Organization for Meteorological Satellites
EVA	Extra-Vehicular Activity
FAA	Federsl Aviation Administration
FCC	Fed. Communications Commission
FCCSET	Federal Coordinating Council on Science, Engineering & Technology
FEB	Functional Energy Block
FEWS	Follow-on Early Warning System
FFRDCs	Federally Funded Research & Development Centers
FLTSAT	Fleet Satellite
FTS	Flight Telerobotic System
FYDP	Five Year Defense Plan
GEOSAT	US Navy Ocean Survey Satellite
GSFC	Goddard Space Flight Center
GIS	Geographic Information Systems
GLPS	Gun Laying Positioning System
GPALS	Global Prot. Against Limited Strike
GPS	Global Positioning Satellite
GTO	Geostationary Transfer Orbit
HHS	Health and Human Services
HUD	Housing and Urban Development
HYFLITE	Hypersonic Flight Test Experiment
ICBM	Inter Continental Ballistic Missile
IFOV	Instantaneous Field of View
ILC	Initial Launch Capability
INMARSAT	International Maritime Satellite Org.
INTEL	Intelligence Service
INTELSAT	International Telecommunications Satellite Organization
IOC	Initial Operating Capability
IPB	Intercept Priorities Board
IPO	Integrated Program Office
IRAS	Infrared Astronomy Satellite
IRBM	Intermediate Range Ballistic Missile
IRS	Indian Remote Sensing (Satellite)
ISRO	Indian Space Research Organization
ITER	Intn'l Thermonuclear Exp. Reactor

JAST	Joint Advanced Strike Technology Program
JCS	Joint Chiefs of Staff
JDISS	Joint Deployable Intel Support Sys.
JERS	Japan Environmental Research Satellite
JTAG	Joint Test Action Group
LandSat	Nasa's Land Satellite
LEO	Low Earth Orbit
MeV	Mega-volt
MILSATCOM	Military Satellite Communications
MILSTAR	Military Communications Satellite
Mir	Russian Space Station ("Mir" means "peace")
MIRV	Multiple Independently Targetable Re-entry Vehicle
MOL	Manned Orbiting Laboratory
MOU	Memorandum of Understanding
MSG	Meteosat Second Generation
MSI	Multispectral Scan Imagery
MSS	Mission planning system of a tactical Air Force
MTPE	Mission to Planet Earth
MWe-yr	Mega-watt year
MW_{th} -	Megawatts
NARSIA	No. American Remote Sensing Industries Association
NASA	Nat'l Aeronautics and Space Admin.
NASP	National Aero-Space Plane
NERVA	Nuclear Engine for Rocket Vehicle Application
NIST	National Institute of Standards & Technology
NLS	National Launch Vehicle
NMD	National Missile Defense
NOAA	National Oceanic & Atmospheric Administration
NORAD	No. Am. Aerospace Defense Com.
NPOESS	National Polar-Orbiting Operational Environmental Satellite System
NPR	National Public Radio
NRO	National Reconnaissance Office
NSC	National Security Council
NSTC	National Science & Technology Council
OACT	Office of Advanced Concepts & Technology, NASA
OCST	Office of Commercial Science & Technology
OMB	Office of Management and Budget
OSD	Office of the Secretary of Defense
OSI	Office of Special Investigations
	Office of Space Industry (Hawaii)
OSS	Office of Space Science
OSTP	Office of Science Technology Policy
PAC-2	Patriot missile upgrade
PADS	Position Azimuth Determination Sys.
PDDs	Presidential Decision Directives
POM	Proof of Manufacturing
ppb	Parts per billion
RFP	Request for Proposal
ROI	Return on Investment
RPV	Remotely Piloted Vehicle
RS	Remote Sensing
SATCOM	Satellite Communications
SAWC	Space Applications & Warfare Cent.
SAB	Space Applications Board
SBIR	Space-Based Infrared Radar
SBIR	Small Business Innovations Research
SCUD	Mid-range battlefield missile
SDI	Strategic Defense Initiative
SDIO	Strategic Defense Initiative Org.
SEI	Space Exploration Initiative
SETI	Search for Extraterrestrial Intelligence
SHF	Super High Frequency
SLBM	Submarine-launched Ballistic Missile
SOUTHCOM	US Southern Command
SSDC	Army Space & Strategic Defense Command
SSRT	Single Stage Rocket Technology
SSTO	Single-Stage-to-Orbit
TAC 3	Navy's new tactical computer
TAF	Tactical Air Force
TAU	Thousand Astronomic Unit
TDRS	Tracking and Data Relay Satellites
TENCAP	Tactical Exploitation of National Capabilities
TESS-3	Tactical Environment Support Sys.
TIROS	Television Infrared Observation Sat.
TISS	Tactical Information Supply System
TMD	Tactical Missile Defense
TOA	Total Obligational Authority
TRACC 3	Tracking, Command, Control & Communications System
TRADOC	Training and Doctrine Command
TRE	Tactical Receiver Equipment
TVRO	TV-receive only
TW/AA	Tactical Warning/Attack Assessment
TXP	Toroidal Plasma Experiment
UAV	Unmanned Air (Aerial) Vehicle
UHF	Ultra High Frequency
UFO	Unidentified Flying Object
UN	United Nations
UOES	User Operational Evaluation System
USGS	U.S. Geological Survey
USSPACECOM	US Space Command
UTC	United Technologies Corp.
VORTAC	Very High Frequency, Omnidirectional (Radio) Range Tactical Air Control
WiFS	Wide Field Sensor

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